THURSDAY, FEBRUARY 22, 1900.

A NEW DEPARTURE IN CYTOLOGY.

Fixirung, Färbung, und Bau des Protoplasmas. Kritische untersuchungen ueber Technik und Theorie in der neueren Zellforschung. Von Dr. Alfred Fischer, a.o. Prof. der Botanik in Leipzig. Mit einer coloristen Tafel, und 21 abbildungen im text. Pp. x + 362. (Jena: Gustav Fischer, 1899.)

IT is many years since Dr. Routh administered to a youthful aspirant after literary fame the celebrated advice to "verify your references," and no matter what be the branch of learning concerned, the maxim applies, *mutatis mutandis*, with equal force to all. Certainly no one devoted to science can afford to disregard it, since extracts from the difficult text of nature are hardly less liable to errors of transcription than to those of interpretation. And this is especially true in the case of a study such as that of cytology, for not only is the evidence difficult to obtain and the degree of its relevancy to a particular problem hard to decide, but its very authenticity is not to be admitted without full proof.

Prof. Fischer has thoroughly deserved the gratitude of all who are interested in the investigation of cell phenomena, for he has opened up (even if he cannot claim to have originated) a new and fruitful path of inquiry in attacking the very foundations on which our knowledge of cell structure is based. He has, in fact, conducted an extensive investigation into the reactions obtaining between certain well-known proteids (in the widest sense of the term) and the fixatives and stains which are in common laboratory use.

The importance of this procedure becomes at once apparent on reflecting that protoplasm, when killed, becomes in fact something else, yielding, *inter alia*, a complex mixture of proteids, and that it is just these proteids which are so grouped in the dead cell as to produce what we term its structure.

Many of the proteids can be tolerably easily recognised and classified, and it is clearly imperative to learn as much as possible about them and their individual reactions with the substances employed to kill or fix the cell contents. It may be regarded as fairly certain that "fixation" really implies the *precipitation* of substances which, in the living cell, existed under other forms and other conditions. In some cases, *e.g.* when salts of the heavy metals are used, it is probable that the metallic base enters into combination with some, at any rate, of the proteids, whilst in the case of some other fixatives, such a possibility appears to be excluded. But in whatever way the precipitates may be produced, it is obviously a matter of prime necessity to ascertain the extent to which they correspond, in position and in form, with the structural elements of the living cell. An instance in which such a correspondence is probable is supplied by the chromosomes of a dividing nucleus. These bodies can be identified in the living condition, although it is not until after fixing that the finer details of structure become apparent, and for which it would be hopeless to look in the living nucleus. Now it is precisely as to the extent to which we are justified in regarding these details as faithfully reflecting *living* structure that the greatest uncertainty prevails.

Many persons are satisfied by the comparative uniformity exhibited in "well-fixed" specimens when prepared by diverse methods. But can the criterion of trustworthiness be safely sought in exquisite differentiation alone, even though a multitude of reagents should conspire to produce it, unless the specific effects of each fixative be thoroughly understood? Perhaps few reasonably cautious cytologists, thus pressed, would return an immediately affirmative answer, although they could hardly conceal from themselves the fact that it is too often on the tacit admission of some such postulate that many of the current theories and hypotheses depend. Small wonder then if these should sometimes prove untenable when the soundness of their foundations has been insufficiently tested.

Prof. Fischer devotes the first seventy-two pages of his book to the consideration of the reactions of certain selected proteids (*e.g.* albumen, albumose, peptone, nuclein) with the reagents commonly employed for killing and fixing the cell contents. The amount of detail is almost bewildering, and, indeed, throughout the book the reader seeks in vain for short and clear summaries of the many lines of argument.

The results obtained are such as to throw considerable light on the operations of killing and fixing. Some reagents, *e.g.* osmic acid, although they rapidly destroy life, do not precipitate the proteids; and this fact explains why cells killed with osmic acid retain a considerable resemblance to the living condition. But the action of osmic acid in this respect is easily affected by the presence of other substances, *e.g.* acids, in the cell, whereby further changes may be induced. Other reagents, such as acetic acid or alcohol, bring down some of the proteids, the rest being left in solution; whilst, finally, there are still others, for example, chromic acid or mercuric chloride, which have a far greater fixing (*i.e.* precipitating) power.

Again, the nature of the precipitate is often characteristic: witness the coagulum produced in albumen, nuclein, or nucleic acid by treatment with mercuric chloride; whereas, if chromic acid be employed instead, nucleic acid and albumose are both precipitated in a granular form. But the final result is also subject to some amount of modification, depending on the conditions of the experiment. Thus alkalinity, acidity, excess of either reagent, may all affect it, though in a way which can be calculated and reckoned with. A consideration of no little importance attaches to the fact that, in mixtures of proteids, the individual precipitate-form characteristic of each proteid is still retained when they are thrown down by a fixative, and the bearing of this upon the probability of arriving at a correct understanding of the structure of living protoplasm, from a study of fixed preparations, becomes immediately obvious. Indeed, it is extremely probable that much of the so-called "structure" may turn out to be the mere expression of chemical idiosyncrasy—interaction between proteid and reagent—rather than an instantaneous photograph, so to speak, of the true structure of protoplasm. An example will make this clear. Altmann's solution (consisting of potassium bichromate and osmic acid) produces a very constant appearance in protoplasm, consisting chiefly of

well-defined granules lying in a spongy framework. But a closely similar image can also be produced by substituting a mixture of serum-albumen and deutero-albumose for the protoplasm, and it is at least open to suspicion that the appearances are *evoked* in the protoplasmic corpse, as they certainly are in the mixture, by the definite action of the chemicals employed.

But, although it may be conceded that the study of fixed (and stained) preparations is, after all, largely one of the structure and relations of precipitates, it would be going a deal too far to regard this as at once invalidating the results which have been arrived at by a careful use of histological methods. Thus in many cases it will readily be admitted that the precipitation-figures indicate and correspond with regions of active and special metabolism within the cell. It may well be, however, that we shall find ourselves on safer as well as on more fruitful ground in investigating the nature of the substances involved in cellular activity rather than in studying the minute details of structure. Some, indeed, have already regarded as illusory many of these appearances which now would seem to have been summoned into existence by the mere act of coagulation or precipitation. Zacharias, as well as Fischer, though working on different lines, has shown how much valuable knowledge can be obtained by micro-chemical methods, and these are still in their infancy.

After dealing with fixatives, the author next turns his attention to staining, and in particular to the effects of the aniline dyes. It is obviously impossible to discuss the whole of this complex subject here. Those who are interested in the matter may turn to Prof. Fischer's treatise itself, where they will find an immense supply of further information and facts.

The author arrives at the conclusion that a chemical (in the ordinary acceptation of the term) interaction between dye and tissue elements is out of the question, and that the process of staining is a purely physical one depending on the "adsorption" or condensation of the dye on the surface of the ultimate particles (micellæ) of the stainable substance. It is pointed out that acid dyes differ in important physical characters, such as solubility, from the basic stains; and it is argued that these differences, coupled with the physical structure of the body to be stained, will account for the particular colour reaction produced in any given instance. These conclusions will come as a shock to those who have been accustomed to pin their faith on the aniline dyes, and who have seen in "Cyanophily" or "Erythrophily" an index of chemical distinction between the various groups of cell-constituents. The evidence brought forward by Dr. Fischer in support of his thesis is based not only on the observations and practice of technical workers; he has himself contributed an elaborate series of experiments designed to elucidate the phenomena of dyeing; and if his results are not always free from ambiguity, some margin, as he himself hints, must be left as a tribute to our imperfect acquaintance with the objects and processes concerned. Nevertheless, so far as the positive evidence goes, it certainly seems to afford confirmation of the physical, rather than the chemical, theory of staining phenomena.

Following the same plan as that which yielded good results in his investigations on fixatives, the author experimented with precipitates of known proteids. He finds that no constant relations exist between the staining capacity of a proteid and its power of forming a precipitate on adding the dye to its solution. Thus nucleic acid, which takes up basic, but not at all acid, dyes, is only precipitated from solutions by the former. On the other hand, albumen, whilst also only precipitated by basic dyes, is stained more especially by acid ones.

It is very well known that it is essential in the case of certain fixatives (*e.g.* those containing chromic acid or platinum salts) to carefully "wash out" the superfluous fixative before staining is possible at all. Prof. Fischer uses these facts to support his views, assuming that just as the stain may be adsorbed, so also, in some cases, the fixative may be attracted and held, leaving no place for the stain until it is thoroughly washed away—a process which is often attended with considerable difficulty. The same peculiarity of inhibiting staining is shared by some other substances, though they may form no precipitate with the dyes employed; thus tannin, which precipitates basic, but not acid, dyes, impartially inhibits the staining power of them all in proteids saturated with it. Again, although platinum chloride precipitates eosin but not acid-fuchsin, a proteid fixed with this reagent and not subsequently washed will not take up either dye; whilst chromic acid, if it be substituted for the platinum salt, although behaving in precisely the same way towards *solutions of these dyes*, does not hinder their staining at all.

As might, perhaps, have been anticipated from the author's own standpoint, the fixative used may modify the primary capacity for stains possessed by the proteid, but this secondary effect is probably to be connected with a changed molecular or micellar form.

Another argument against a chemical explanation is founded on the behaviour of precipitates of even the same proteid towards mixtures of stains. Precipitates of albumose, for example, which contain granules of various sizes, select the stain according to their bulk, the larger granules taking up and retaining the acid (more rapidly diffusible) dye, whilst the smaller ones are coloured by the basic stain. There seems no reason to suppose that the granules differ chemically *inter se*, although this objection has actually been raised in other quarters, and Fischer interprets the effect as being due to the difference in solubility, concentration, and rate of diffusibility of the two classes of stains, coupled with the degree of tenacity with which, when once adsorbed, the molecules of dye are retained on the micellæ of the proteid. The reversals of stain so frequently met with under these conditions appear also to tell in favour of the physical or mechanical hypothesis. But the author by no means confines himself to a study of simple proteids, he also discusses the bearings of his results on the staining reactions of protoplasm itself.

Amongst the more interesting of the latter may be reckoned the characteristic differences exhibited by the nucleus of the male and female gametes respectively. Dr. Fischer regards the cyanophily of the male as due to the dense state of aggregation of its substance, and not at all as indicative of a chemical dissimilarity between it and the erythrophil female nucleus. His case is not weakened by the fact that, in those instances where

fusion of the two nuclei is delayed, the male pro-nucleus as it grows and gradually assumes a less dense appearance, approximates more and more in its staining reaction to that of the female pro-nucleus. Nevertheless, it might also be argued that the very state of dense aggregation implies a chemical difference, especially when it is recollected that growth perhaps involves much more than mere expansion of bulk.

But it must not be supposed that the evidence adduced is everywhere immediately favourable to the author's standpoint. There are, in fact, many anomalies, especially in the case of certain basic dyes, which require to be cleared up before Dr. Fischer's views can command universal acceptance. It is, however, as has been already said, impossible to do justice to this part of his book within the limits of a single article. But as the facts adduced will be largely new to most cytologists, it has been thought best to utilise the available space in pointing out a few lines of the argument rather than, by venturing on detailed criticism, to trespass on the domain of the chemist or physicist.

By no means the least interesting part of the book is that devoted to an inquiry into the origin of cell-structure, spindle-fibres, centrosomes, and the like. As regards the spindle-radiations, the results of some remarkable experiments are detailed, and these are quite startling owing to the apparent fidelity with which certain of the most characteristic features of cellular activity have been successfully imitated. Other investigators have produced, ere now, appearances resembling the achromatic spindle, but the figures have never attracted serious attention, as the analogies between them and a protoplasmic structure appeared to be too feeble. In the present case, however, it is very different, since the materials employed *are* akin to those which exist in the cell.

By injecting elder-pith with sundry colloids (albumen, albumose, &c.), and then treating sections of the pith with various fixatives, the author succeeded in obtaining spindle structures closely resembling those exhibited in a preparation showing karyokinetic figures. Not only this, but it has been found possible to ascertain at least some of the conditions which are necessary to their formation.

In the first place, there must be present in the cell some foreign indifferent body which may serve as a centre from which the radiations may start. Such a body is often provided in the dead but persistent fragment of the original cell-nucleus. Secondly, the precipitating action of the reagent must be slower than its penetrative power—it must have completely saturated the fixable substance as far as to the foreign body, before the physical change of precipitation sets in. Unless these conditions are both complied with, no radiations will arise. The importance of the second point at once becomes apparent when one recollects the emphasis laid on *rapidity of penetration* as one of the essentials of a good "fixative," and an analogy between the first condition and the origin of spindle fibres is seen in those multipolar spindles associated with large heterogeneous bodies in the cell protoplasm, which were first pointed out by the present writer in 1893, and which have since been confirmed by Mottier and many other investigators. Similar results were also obtained by allowing fixatives to diffuse from capillary tubes into the fixable proteids; the radiations then started from the surface of the concentrated drop of fixative in such a way as to simulate the appearance of an attraction sphere.

The author exercises an admirable restraint in instituting comparisons between these results and those observed in preparations of cells, but it must not be forgotten that there is reason to believe that substances very similar to, if not identical with, those employed by him do really exist at least in the killed cell.

Naturally much is still left obscure. Why, it may be asked, should the precipitates only take the form of radiations during mitosis? If we attempt to frame an answer temporarily satisfactory on chemical or even microchemical grounds, we should have to trek into regions far outlying the limits of our present knowledge.

A discussion of cytological phenomena and of the various theories of protoplasmic structure and its supposed mechanism, occupies the remainder of the volume. The centrosome in particular comes in for a lengthy criticism, especially as regards those alleged for the higher plants. The author, on good grounds, concludes that these are merely cast out nucleoli, or, at any rate, in no sense to be regarded as special cell organs. He points out the fallacies which have led to the obscuring of the true issues in the past, and he treats the well-known case of *Lilium* with special severity.

It will be apparent that Prof. Fischer's book is not only startling from the novelty of its contents, but it is even almost revolutionary in its tendencies. But the cytologist need not be unduly alarmed, nor fancy that all his tenderly nurtured theories must of necessity dissolve forthwith into vapour. Probably much of the "structure," which was believed in by the extreme adherents of the particulate school may turn out to be due to *post-mortem* effects, and to possess no counterpart during the life of the cell; but the broad distinctions of cytological structure will still hold good, even though they may not be able to support the weight of the theories that have been erected upon them. The chromosomes, the spindle-fibres, the centrospheres (where apparent) all represent definite facts of protoplasmic activity, although the conclusions which have been drawn respecting them may stand in need of revision. But it is well that we have been thus recalled to examine once again, and more minutely than heretofore, the very foundations on which our knowledge of cell phenomena rest. *Diligenter explorata principia ponantur.* J. B. FARMER.

RESEARCH IN PREVENTIVE MEDICINE.

Transactions of the Jenner Institute of Preventive Medicine (late British Institute of Preventive Medicine). Second Series. Edited by Allan Macfadyen, M.D., B.Sc., Director. Pp. xv + 253. (London: Macmillan and Co., Ltd. New York: the Macmillan Company. 1899.)

DURING the last year the Jenner Institute of Preventive Medicine has passed through a most notable phase of evolution; with it has become associated the name of the father of modern preventive medicine, whilst its sphere of usefulness has been

enormously extended through the munificent liberality of Lord Iveagh, who, in placing at the disposal of the Council a sum of no less than a quarter of a million sterling, has shown an example of keen insight into the needs of scientific investigation in this country that must, ere long, have most important results in raising the standard of experimental research in the field of medicine.

From a perusal of the Second Series of the *Transactions*, published some short time ago, it is evident that the increased facilities offered for the carrying on of investigations in the laboratories have already borne abundant fruit, the papers in the present volume being not only more numerous but also relatively of considerably greater importance than those that appeared in the first volume.

The introduction contains a fairly full descriptive account of the laboratories in the various departments in the beautiful building on the Chelsea Embankment, an account which will be of considerable interest to those who would know what has been the development of laboratory accommodation and apparatus during the last few years.

The first paper, from the pen of Prof. Ehrlich, "Observations upon the constitution of the diphtheria toxin," has great value, especially just at the present, as he describes his "toxin spectrum," a careful study of which promises to throw light on the constitution of these most complicated bodies. Dr. William Bulloch also makes a contribution to the study of diphtheria toxins A new pathogenic streptothrix is described by Dr. George Dean. This organism produces in the horse a disease which might be described clinically as actinomycosis, from which however it differs very considerably in certain important points. He considers that it is much more nearly allied to the bacilli of the diphtheria and tubercle groups than to the moulds, and that actinomycosis is a disease due not to one specific micro-organism, but to a number of allied species. Dr. R. T. Hewlett contributes two papers; one, "Preliminary observations on the occurrence of the bacillus enteritidis sporogenes (Klein) in ulcerative colitis and in the normal dejecta"; the other "On Neisser's diagnostic stain for the diphtheria bacillus." In an article on "the bacteriology of the normal conjunctival sac from a report of 200 cases, and its practical bearing on the utility of antiseptics in ophthalmic surgery," Mr. Arnold Lawson urges the abolition of antiseptics in ophthalmic surgery on the ground that the strongest antiseptic is the healthy conjunctiva itself. He maintains that in order to eliminate suppuration as far as possible from the list of accidents that may occur after operations, only two factors have to be attended to: (1) perfect asepsis on the part of the operator, his instruments, dressings, &c., and (2) the healthy condition of the conjunctival sac. Mr. J. E. Barnard contributes an interesting and ingenious article on photogenic bacteria. He concludes that the different species of phosphorescent bacteria described are probably identical or merely closely allied varieties. They are all markedly pleomorphic, readily undergo involution, and only phosphoresce in the presence of oxygen. The phosphorescent principle may be kept back by a Berkefeld filter, and anything that affects the vitality of the organism affects likewise the production of light. Dr. Alfred Salter writes "on the pathogenicity of the pseudo-diphtheria bacillus, and its relation to the Klebs-Lœffler organism." He finds that the pseudo-diphtheria bacillus has the power of producing a non-toxic but antitoxin-fixing substance, and he argues that this is an additional fact in favour of the pseudo-diphtheria bacillus and the Klebs-Lœffler bacillus being practically identical. Dr. Arthur Harden, in Part i. of a paper dealing with "the fermentation of sugars by bacillus coli communis and allied organisms," gives a short history of the subject and a number of his own experiments, from which he draws the following conclusions: (1) the organisms that he used, when grown anaerobically in a medium consisting of beef broth alone or in conjunction with peptone, produce inactive lactic acid from the glucose, but may, when a very vigorous growth occurs, produce a small amount of the active lævo-rotatory acid. The lactic acid produced amounts to about 50 per cent. of the weight of sugar decomposed; (2) in media containing peptone but no beef broth, a mixture of the inactive acid with the lævo-lactic acid is formed; (3) the gas produced by the decomposition of the glucose consists of 1 to 1·3 vols. of hydrogen to 1 vol. of carbonic acid gas. Mr. Sydney Rowland, writing on the structure of bacteria, puts forward the thesis that in the actively living bacterial cell no reticular structure can be demonstrated, such reticulum only being present except when the cell is progressing either to spore-formation or to granule-formation. In the actively living cells, which consist of cell wall, cell plasma and granules, the cell wall is a progressive formation and becomes finally a rigid structure. The fine refractile granules staining vividly with roseine may participate in cell-division or may be extruded from the cell through the cell wall. These granules are present even in an embryo on emergence from the spore-case. Drs. Allan Macfadyen and Frank R. Blaxall continue their article on thermophilic bacteria, which are specially important as regards the fermentation in ensilage and the digestion of cellulose.

Mr. G. Harris Morris gives a short account of the technical applications of bacteriology. One of the shortest but most important papers in the whole collection is a record of an experiment carried on with the object of determining the etiology and pathology of cancer. All those interested in this subject will anxiously await further and corroborative evidence of the very striking result obtained by Dr. H. Lambert Lack. Dr. Allan Macfadyen records the important symbiotic fermentation, in which pure cultures of a mould, instead of diastase, are used for the purpose of saccharification and fermentation, thus being accompanied by a pure symbiotic fermentation on the addition of yeast. Dr. Macfadyen corroborates many of Calmette's observations on this point. Mr. Joseph Lunt enumerates and describes a series of eleven organisms of the bacillus *Coli communis* group, which he has been able to isolate from drinking water, &c.; and Dr. Arthur Harden contributes a short note on the action of hydrogen peroxide and the oxides of copper on formaldehyde.

A number of interesting "Laboratory Notes" and "Notes on Apparatus" complete a most creditable volume of transactions. The illustrations, both process blocks and photo-prints, which are very numerous, are all well reproduced.

PHYSICAL PRINCIPLES AND MORAL PRECEPTS.

The Scientific Basis of Morality. By Dr. G. Gore. Pp. viii + 599. (London: Sonnenschein and Co., Ltd., 1899.)

DR. GORE is one of the increasing many who feel that much in conventional morality is baseless, while more is only not crumbling because built up on other foundations than those commonly alleged. Driven to look for salvation to that science in which we perforce believe with the conviction of practical life, he too would lay bare the groundwork of the coming ethics of naturalism.

"About the year 1880 the author published a small book, entitled 'The Scientific Basis of National Progress, including that of Morality.' That book has long been out of print, and having been repeatedly advised to write a more complete statement of the relations of science to morality, &c., he has endeavoured to do so."

Unadvisedly.

Such a book as the present must be the despair of a reviewer who sympathises with its object. If extent of reading within certain well-defined limits and a wide range of interest could make a great book, Dr. Gore's advocacy of the naturalistic basis of ethics, and of the maxim that the laws of science are the chief—nay, the only—guides of life, might be what he claims that it is: a book "largely one for the future," "written in some respects in advance of its time," "for those whose minds are in a fit condition to receive scientific truth." As it is, it is a commonplace book in more senses than one. It is not free from the suspicion of bookmaking. It quotes nearly 350 lines, including three stanzas from the hackneyed "Psalm of Life," of Longfellow; more than 200 lines from Pope. It devotes two whole pages in one place to citations from a fatuous print, entitled "Is Science Guilty?" Many familiar sentences are given at second-hand—*e.g.* some of Kant's *vid* the Archbishop and the Dean of Canterbury. And Dr. Gore is not always either relevant or happy in his quotations. Yet excuse for "the brevity of the treatment" is asked of "those who are competent to investigate the matter" upon the ground of "the great amount of evidence which has been omitted in order to limit the size of the book."

All this notwithstanding, if the kernel of this, which "is not a polished literary treatise, but a scientific production," were of a sound character, we would have to accept it thankfully. But a certain lack of analytical insight makes Dr. Gore's best sections curiously ineffective.

For instance, when our author has pointed out quite correctly that any known or knowable existence must be in relation to us, since it could not otherwise affect us directly or indirectly, and when he has referred with approval to G. H. Lewes, to the effect that there are no relations of the known to the unknowable, though there are to that which is at present unknown, he spoils his effect by announcing that "man is related to all things," a dictum which loses sight of the scepticism implied in all naturalism, and is as dogmatic as the mythology which Dr. Gore rightly rejects. Phenomenalism, which at the limit can admit of no lacuna, may be a belief or a natural hypothesis. It must not amount to a dogmatic denial of all else.

Again, when Dr. Gore has laid down a determinism which satisfies the demands of science, he proceeds to quote writers with approval, whose doctrine is not his own, but an indeterminism with a limited range. And in treating of evil, he fails to follow out his determinism to its logical consequence, viz., that to call the actual either good or evil is absurd. His proof for the relativity of evil is valid for the relativity of good also, but he preaches the essential optimism of science, continuing to call the world process good, perfect and the like. If Dr. Gore chooses to call the actual as such good, and to say that since there is nothing not actual, evil accordingly is non-existent, he may of course do so. But he solves no problems thereby. When, in treating of pain and of ignorance, he sees that relative ignorance and relative pain, viz. ignorance and pain incident to the stage of progress at any moment attained, are necessary, he surely goes beyond his data in taking the ignorance and the pain as good because any other than the actual would be worse. On his own principles anything other would be impossible; but does not that rather prove the indifference of the actual to that ideal point of view from which we use the relative and partial epithets "good" and "evil"?

Again, Dr. Gore is obscure as to the formula under which he conceives the relation of neurosis to psychosis. He tells us that ideas produce tears, and that mind may be viewed as a mode of energy existing only in nervous substance; while he quotes with approval the famous description of thought as the secretion of brain, just as bile is of the liver. In saying that "mind is dependent upon brain because it is not proved to exist without it," our author seems to state a truth with a false ground for holding it.

Once more, Dr. Gore thinks it an additional argument against Paley's stolen illustration of the watch implying a watchmaker, to say that nearly every part of a watch is now made by means of inanimate machinery, and the watchmaker only puts its pieces together. As if the unity of purpose in the process as a whole and the creative activity back of the machinery itself would not satisfy Paley well enough.

Dr. Gore's rules of conduct according to naturalism might be all summed up under the Stoic formula of life according to nature. His economics are opposed to trades unionism and to united action on the part of the working classes in the direction of shorter working hours. The efficiency-theory of wages which Dr. Gore apparently holds does not give ground for this attitude. Dr. Gore's logic lays too much stress on "induction" of the kind which, as a modern teacher puts it, "takes unanalysed concretes as ultimate."

Much of what Dr. Gore has to say would pass as interesting and thoughtful, though not either original or clearheaded, matter, if put forth in a volume one-quarter the size.

H. W. B.

OUR BOOK SHELF.

Exercises in Practical Physics. In two parts. By R. A. Gregory and A. T. Simmons. Part i. pp. vi + 200; Part ii. pp. vi + 174. (London: Macmillan and Co., Ltd., 1899.)

THESE two volumes contain a graduated series of physical experiments, compiled with the intention of furnishing a basis upon which teachers may found their courses of lessons. Special attention has been devoted to providing a large and diversified number of exercises exemplifying each of the principles considered, and the authors have also admirably succeeded in bringing together many ingenious experimental methods devised by various teachers of their acquaintance. Throughout both volumes the insertion of numerous illustrations of the apparatus in position is a great help to the correct understanding of the text, and, indeed, the authors state that the descriptive matter has been purposely limited to the amount necessary for the proper working of the experiments.

Part i., constituting the first year's course, embraces experimental work in mensuration, hydrostatics, elementary mechanics, and the first principles of heat. The apparatus necessary for each experiment is first given; then the setting up, observations to be made, and finally, the deductions which are to be drawn from them. The simple methods of demonstrating many of the properties of matter are excellent. Without appearing to be over-critical, it is impossible to avoid regretting that the term "apparent loss of mass" should have been used to denote the change produced on immersion of a solid in water to determine its specific gravity. The change is simply a partial neutralisation of the gravitational attraction on the solid, which is detected by a difference in the weights required to balance it; but this does not suggest that the *mass* of the body has altered. This is a minor point, but the relations of *mass* and *weight* are a real difficulty to the majority of elementary students.

Part ii. is designed to serve for a second year's course, and furnishes experiments illustrating the chief principles of heat, light, sound, magnetism, and electricity. The experiments on heat in Part i. only have reference to the construction and use of thermometers, thermal conductivity, and radiation. To render the second part complete, these sections are repeated in it. A series of tables are given at the end, comprising most of the data required in the working of the course of experiments. The style of originality and simplicity is repeated in this second volume, and the entire course can be confidently recommended to teachers of the subject. C. P. B.

Abhandlung der Dynamik. Von D'Alembert. Pp. 210. *Ueber die mathematische Theorie der electrodynamischen Induction.* Von Ricardo Felici. Pp. 121. (Leipzig: Wilhelm Engelmann, 1899.)

UNDER the title of "Ostwald's Klassiker der exacten Wissenschaften," Messrs. Engelmann publish a series of small volumes intended to supply what has been for some time a want in our systems of scientific education, namely, the want of historical knowledge and of a proper appreciation of the great works on which our scientific theories have been built up.

Every student of mechanics has heard of "D'Alembert's Principle," but in these days few take the trouble to ask who D'Alembert was, how he discovered his principle, or where and when he published it. The reproduction of the "Traité de Dynamique" (1743) will do much, not only to enlighten students on these points, but to give an insight into the state of knowledge existing at the time the principle was discovered. Those accustomed to the modern style may, for example, be interested to see D'Alembert's equations written in the form $d^2x = a\,dt^2$. The present volume has been translated and edited by Arthur Korn, who has supplied a biographical notice of D'Alembert and numerous explanatory notes, chiefly mathematical.

The second volume is a translation of the papers published by Felici, in 1854–1855, in the "Annali della Università Toscana." After Faraday's great discovery, he and others confirmed the quantitative law of magnetic induction in a number of cases, and we learn that Felici's chief service to the cause of science was that he was the first (Gaugain following two years later) to verify the laws of induction between two voltaic currents. The present volume has been translated by Dr. B. Dessau, of Bologna, and edited by E. Wiedemann. It is No. 109 of the series, D'Alembert's work being No. 106.

Équilibre des Systèmes Chimiques. By J. Willard Gibbs. Translated by Henri le Chatelier. Pp. xii + 212. (Paris: Georges Carré and C. Naud, 1899.)

THIS is a translation of Prof. Gibbs's paper on the equilibrium of heterogeneous systems, Part i. (chemical phenomena), published in the *Transactions* of the Connecticut Academy in June 1876. It is the second of the three classical thermodynamic memoirs by Prof. Gibbs, and is at the same time the best known and the most important, being the paper in which the well-known "law of phases" was first enunciated. Prof. Le Chatelier has added several explanatory footnotes, and an introduction summarising a few of the principal new laws and notions of experimental interest, for which the foundations have been laid by Prof. Gibbs in the memoir in question. This summary will be useful in giving readers some idea of the phenomena to which Prof. Gibbs's conclusions are applicable, a point of no small difficulty in reading the original paper. Prof. Le Chatelier translates "heterogeneous systems" by "systèmes chimiques" on the ground that "hétérogène" in French refers to a difference of physical rather than chemical state. The translator's own researches are sufficient guarantee of his eminent qualifications for the work that he has accomplished in the preparation of this French edition.

Elementary Trigonometry. Oliver and Boyd's "Educational Series." By A. J. Pressland and Charles Tweedie. Pp. viii + 342. (Edinburgh: Oliver and Boyd, 1899.)

THIS text-book is not intended to meet the requirements of any special syllabus, but is simply an elementary course on trigonometry. On this account, the authors have had a free path to pursue, and they have produced a well-arranged course on the subject, which will be found most useful for those who are getting up this subject. The range of the book may be gathered from the statement that the three parts into which it may be divided deal with, first, the definitions and properties of the trigonometrical ratios concluding with the Addition Theorem; second, the application to computation and to the geometry of the triangle and quadrilateral; and, last, to the inverse functions and other applications. The student is made thoroughly acquainted with logarithms and the application of mathematical tables, and in the explanation of the rule of proportional parts Prof. Chrystal's method has been followed. The examples are numerous and suggestive.

A Century of Science and other Essays. By John Fiske. Pp. vii + 477. (London: Macmillan and Co., Ltd., 1899.)

THE main title of this volume is entirely misleading, for it is only the title of one of fourteen essays. It gives the idea that the advances of science during the present century are dealt with, but what science is in the work is of a very popular character, most of the contents being concerned with subjects which, with the most liberal interpretation, must be placed outside the bounds of natural knowledge, and therefore outside our province of comment.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Lord Kelvin on the Origin of Granite.

IN 1897 Lord Kelvin delivered an address to the Victoria Institute on the age of the earth, Sir G. G. Stokes being in the chair. Incidentally, the address included theories of the origins of granite, basalt and continents, and touched on the question of the inclusion of gases in various rocks.

At the late meeting of the British Association two sectional Presidents referred to Lord Kelvin's theory, both apparently accepting his lordship's conclusions without noticing his premisses.

My old master, William Pengelly, used to teach that as every theory depended on many facts, if but one fact were disproved the theory fell to the ground. From this aspect there are several points in Lord Kelvin's theory which seem to require elucidation.

Lord Kelvin starts from a period in the earth's evolution when a lava ocean forty kilometres deep covered a solid nucleus. The specific gravity of the liquid lava is assumed to be 2·50. It is also assumed, on what seem firm grounds, that solid lava would sink in fluid lava, and on more doubtful grounds, that all minerals crystallising out of lava would also sink. On this assumption the lava ocean silts up, and the surface does not "freeze" until the forty kilometres of the crust (excepting the future ocean basins) are composed of solid crystals set in an interstitial mother liquor.

According to Lord Kelvin, continents arose from the drifting and unequal distribution of the crystals falling like a "snow shower" through the lava; the ocean basins arising from the contraction of the mother liquor in cooling. The theory is brilliantly unfolded, but there are many technical difficulties, *e.g.* Lord Kelvin's granite, besides being an exclusively primeval rock, is composed of drifted crystals of felspar, mica, quartz and hornblende (or some of them) set in a basaltic matrix. The ultimate mother liquor is made to serve the purpose both of basalt and of the matrix of granite. One gas at least, viz. $C.O_2$, treated as original in basalt, might well arise from the calcite which so often occurs in that rock. But the most serious and far-reaching difficulty is involved in the specific gravity of lava minerals. Assuming the liquid lava to be 2·50, there are several minerals which would float in such an ocean, and if there were but one, it would suffice to provide a floating crust or slag which would blanket the glowing lava and entirely upset all heat calculations based on the consolidation of the earth from within to without.

What perplexes me in the matter is that so many philosophers who accept Lord Kelvin's conclusions hold themselves at liberty to reject his premisses.

For instance, the President of Section E, while declaring his adhesion to Lord Kelvin's time-views as against the geologists, entirely ignores both his continental theory and the main premiss as to the specific gravity of the lava ocean. Lord Kelvin assumes the lava to be 2·50, while Sir John Murray assumes the crust to be 2·50, a most fundamental distinction.

Petrologists have fought desperately over the question of the origin of granite, but so far as I am aware they are agreed on all the main points.

I believe myself that every known fact fits most exactly into the grand working hypothesis that granite is a plutonic rock formed by hydrothermal action and pressure out of a previously existing rock, which consisted in the first place of those light aluminous soda and potash silicates which first consolidated on the surface of the primeval lava ocean. To these silicates we have but to add water, in order to form (so far as constituents go) a typical muscovite granite—absolutely nothing more; indeed, less, as we may omit the soda. The constituents of muscovite ($K_2O,2H_2O,3Al_2O_3,6SiO_2$) are simply leucite ($K_2O,Al_2O_3,4SiO_2$) and water. Introduce sodalite, an even more likely constituent of the primeval crust than leucite, and we have all our materials for ordinary granites, except magnesia, with which, however, Lord Kelvin supplies us by means of eruptions of the basaltic mother liquor.

This is but a working hypothesis, but it will work; whereas Lord Kelvin's novel theory throws the whole problem of granite into inextricable confusion, even starting from the hopeless position of disagreement as to what the term granite denotes, geologically, mineralogically and petrologically.

The whole question seems to turn on one single point, viz. whether the first primeval crust when cold floated on the subjacent lava. According to the elements of mineralogy it would do so; but many physicists have assumed that upon consolidation it would sink. Will not some of the distinguished specialists in mineralogy and petrology pronounce judgment on this question, which is really troubling unlearned and ignorant men who are genuinely seeking information? The conflict of authority is quite overwhelming. A. R. HUNT.

Torquay, February 13.

Effects of Lightning upon Electric Lamps.

I HAVE often seen luminous trails, similar in appearance to those shown in Mr. Webb's photographs (p. 343), in photographs taken at night. That there are any effects in these or Mr. Webb's pictures that cannot be explained by a moving camera, I am unable to convince myself of. The identical form of the discharges from different lamps has been explained by the distance of the discharge causing them. Granting that it is possible to have a discharge, so intricate in character, exactly duplicated at a second lamp (which is scarcely conceivable), their magnitudes in the pictures should be inversely proportional to their distances. But we find that, in the pictures, the scrawls are all of the same size. A lamp close to the camera, and a distant lamp, show the trails *on the same scale*.

The beading of the trails can be easily explained by the alternations of the current, the carbons fluctuating in brilliancy. I am informed that in Dover these periodic fluctuations are very conspicuous. Where a trail turns suddenly, the beads are closer together, due to the motion of the camera being slower when the direction of motion is about to change.

If I remember right, there are one or two cases where we have a very large and brilliant pattern, and several similar ones on a smaller scale. This could be explained by reflection from the inner surfaces of the lens. R. W. WOOD.

London, February 20.

The Fitting of the Cycle to its Rider.

I HAVE read Mr. Hutchins's communication (p. 368) with considerable interest. Mr. Hutchins is at the head of the Forest Department which has been recently established by the Cape Government, and the improved method of riding that he has adopted, in accordance with the views expressed in my recent paper, have evidently been of service to him in traversing the very rough country to enable him to carry out his duties. Mr. Hutchins's experiences so closely agree with my own that I can say little in criticism of his letter. I think, however, that he will find that the gain from the lengthened crank advocated by me cannot be explained by the very simple formula that he gives. My son and I went very carefully into this matter at the time I prepared my paper, and I think if Mr. Hutchins refers to it he will find, if we consider the mechanical advantage apart from the gain in nerve waste, the mathematical analysis of ankling given by lengthened crank both give the only explanation which would be satisfactory to a mathematician. In our explanation the weight of the leg plays a very important part, and it follows therefore that a heavy legged man gets most from our system of riding. R. E. CROMPTON.

Crompton Laboratory, Kensington Court, London, W.

THE point raised by Mr. Hutchins in his letter (p. 368) is worth considering, but Mr. Crompton, who by his wonderful riding has done so much to popularise the use of the long cranks first suggested by Mons. Boulay, is not heavily built. A man who is over fifty cannot move his legs so quickly as when he was younger; and so middle-aged persons, stout or slim, profit greatly by using long cranks and high gears. Most people when in a hurry run upstairs two steps at a time, and bicyclists, whether in a hurry or not, find it an advantage to raise gears and lengthen cranks.

The question is, how far may we go without unduly increasing the weight of our bicycles?

My age is fifty-one, weight 15 stone, height under 6 ft., and,

having tried everything between 5¼ in. cranks with a 54 in. wheel, and my present machine with 10½ in. cranks and 108 in. gear, I can now travel greater distances and climb steeper hills with less effort on a 42 lbs. bicycle than when riding a 28 lbs. machine fitted with 6½ in. cranks and 66 in. gear. I intend to try 11 in. cranks and 120 in. gear, but this necessitates my getting a longer and heavier machine, and it is probable that I shall lose as much as I gain.

The extraordinary ankle-play developed by long-crank men improves their walking; and, after a long hard ride, the difference between their swinging elastic step and the muscle-bound hobble of the short-crank riders is very striking.

Instead of Crompton foot-plates I have just fixed a flanged clip to each pedal, so that the inner edges of the soles of my shoes can be pushed under the clips; and they are almost as comfortable and efficient as the "Otto" straps of years ago.

WM. H. MASSEY.

Twyford, Berkshire, February 17.

Indian Corn.

IN the "Encyclopædia Britannica," vol. xv. p. 309, it is stated that no mention was ever made of maize by Eastern travellers in Africa or Asia prior to the 16th century A.D. Slight doubts about this statement have occurred to my mind lately, while I was reading the Hakluyt Society's "India in the Fifteenth Century." There, in the English translation by the late Count Wielhorsky of the "Travels" of Athanacius Nikitin, the Russian, whose Eastern travels took place about 1470-1474, when the work was written by himself, we read concerning the Indians: "They live on *Indian corn*, carrots with oil, and different herbs" (p. 17). Has this mention of the cereal any weight to countenance the theories which seek to assert that maize was known in the East before the discovery of the Western Continent? Or, does what is meant or translated by the word *Indian corn* here differ materially from *Zea Mays?*

Apropos of these queries, I may mention that A. de Candolle is in error in his post-dating the introduction of maize into Japan on the sole ground that Kaempfer (who was there during 1690-92) does not mention it.[1] According to a native work (Kikuoka, "Kindai Sejidan," 1733, lib. 2, § 4), maize was introduced into the islands about the beginning of the period of Tenshô (1573-91). After Sweet Sorghum (*Sorghum saccharatum*), of earlier introduction with the name *Morokoshi-Kibi* (*i.e.* Chinese-Millet), maize was called *Tô-Morokoshi* (*i.e.* Chinese Chinese-Millet) in the eastern provinces, where, of course, its propagation followed that in the western parts. In the dialect of the latter, where the people were more directly concerned with its introduction, maize was named *Nanban-Kibi*, or Millet of the Nambans (Spaniards and Portuguese), who were entirely excluded from the empire since 1639, which thus would stand as latest possible date of the introduction.

KUMAGUSU MINAKATA.

1 Crescent Place, South Kensington, S.W.

The Production of Electrolytic Copper.

IN a note on the production of electrolytic copper, on p. 371 of NATURE of February 15, it is stated that "Mr. S. Cowper-Coles has hit upon a new plan, in which the copper is deposited on a vertical mandril, which is caused to rotate at a very rapid rate. . . . As a consequence, a smooth and dense deposit has been obtained with current densities approaching 200 ampères per square foot." In reference to this I should like to point out that the idea of rotating the kathode with a view to obtaining greater rates of disposition is an old one. We have had in use at the Owens College for the last seven years a copper depositing tank in which the kathode consists of a vertical mandril 9 inches long and 3 inches diameter kept in rapid rotation, and capable of receiving a good copper deposit with a current of 100 ampères. The arrangement was devised by Mr. Henry Wilde, F.R.S., to illustrate the working of his patent, No. 4515, of 1875, and differs little from that used by Mr. Cowper-Coles. The mandril is driven from above, so that a stuffing-box in the bottom of the tank is unnecessary.

CHARLES H. LEES.

The Owens College, Manchester, February 19.

[1] "Origin of Cultivated Plants," p. 392.

THE WEST INDIAN AGRICULTURAL CONFERENCE.

THE second West Indian Agricultural Conference was opened on January 6 in the hall of the House of Assembly, Barbados, under the presidency of Dr. D. Morris, C.M.G., Imperial Commissioner of Agriculture for the West Indies. There were forty representatives present, including the heads of all the Botanical, Chemical and Educational Departments, as well as the representatives of the principal Agricultural Societies in the West Indies. Some of these gentlemen had journeyed for the best part of a week to take part in the two days' labour that awaited them.

The representatives were received in the hall of the House of Assembly at 10.30 a.m. by his Excellency Sir James Shaw Hay, the Governor, who opened the conference with a short address of congratulation to the Department of Agriculture, and of welcome to the visitors from other Colonies.

The President then delivered his address, which summarised the work done by the Imperial Department during the preceding year, and alluded to some of the problems which were expected to be discussed at the conference: the best seedling canes and their record, Imperial aid for co-operative central factories, reducing cost of cultivation, subsidiary industries which have done so much for Jamaica, Trinidad and Grenada, agricultural education and treatment of diseased plants, were subjects that came under review.

Prof. J. B. Harrison (British Guiana) then read a paper, "Notes on Sugar Cane Experiments," the joint production of Mr. G. S. Jenman and himself, followed by one, entitled "Past and Future Work in Sugar Cane Manurial Experiments," by Prof. d'Albuquerque (Barbados). Both papers covered somewhat the same ground, and were followed by a long discussion. It was generally agreed that nitrogen is the constituent of cane manures which chiefly governs the yield; but the experiments upon the use of phosphatic manures have been contradictory in different places. The application of potash and lime to cane fields gives profitable results in soils where these constituents of plant food are deficient. A discussion of considerable length took place upon the best and most economical way to conserve and utilise the nitrogen and mineral constituents of plant food in farmyard manure; and the desirability of extended trial of leguminous green dressing was urged upon West Indian planters.

Prof. d'Albuquerque, in the next paper, explained "A Method of using Control Plots in Experimental Field Cultivation." The method, which is only applicable where small plots of, say, one-thirtieth of an acre are used, partly consists in weighing the crops from a number of small no-manure (control) plots not far apart, and calculating the no-manure yield of the intervening plots on the assumption that in a uniform field the change of fertility is continuous from one control plot to the near next one. The other part of the method depends upon the manipulation of the figures obtained from the manured plots in relation to the calculated no-manure yields, and the interpretation of results.

The same author in the next paper, "The Possibility of Improving the Sugar Cane (*a*) by Artificial Cross-fertilisation, (*b*) by Chemical Selection of 'Seed Cane,'" under the first head argued that crossing different varieties would lead to the production of canes possessing desirable characters derived from both parents, and detailed some methods by which systematic experiments should be carried out. The second part of the paper dealt with the feasibility of increasing the sugar productiveness of a given variety of sugar-cane by propagating it with tops cut from canes richer than the average of the variety; the practical difficulty is to find a sure test of an inherently rich cane, as opposed to a cane rich because it is riper or more favourably situated.

Mr. J. R. Bovell (Barbados), in his papers on "Rotation and Catch Crops on Sugar Estates" and "Green Manuring as a means of Fertilising Cane-lands in the West Indies," illustrated by plants, seeds, tubercles, &c., brought forward useful information on the yields and values of food crops in Barbados, and the capability of sugar estates of self-support in regard to cattle food, and a useful *résumé* on the relative value of different leguminous plants. Mr. E. E. H. Thorne (Barbados), in "Silos on Sugar Estates in Barbados," gave a valuable account of actual results, and a number of useful practical hints. The Hon. F. J. Clarke (Barbados) and the Hon. Francis Watts (Antigua) gave a history for Barbados and Antigua of the efforts of the planters to erect central co-operative factories; both agreed as to the absolute necessity for improved manufacture if the industry is to survive, and as to the difficulty, so long as bounties last, in enlisting any but Government guaranteed capital, notwithstanding the certainty of a very profitable investment even at present prices.

The conference adjourned at 5 p.m., having devoted the entire day to subjects connected with the sugar industry.

A conference dinner was held the same evening at the Marine Hotel, at which about sixty guests were present. The following day, Sunday, afforded an opportunity of visiting the experimental stations, and a pleasant afternoon was spent at the "At Home" given by Mrs. Morris at "Chelston."

On Monday morning, at nine, the labours of the conference were resumed; the day was devoted to educational and general subjects. A long and important discussion took place upon measures for the inspection and treatment of imported plants in reference to plant diseases. The questions submitted were: Shall any or all of the following measures be adopted by legislative enactment?:—

(*a*) Total prohibition in certain cases.

(*b*) Inspection at port of entry, with power to destroy, quarantine or treat infected plants.

(*c*) Certificate from shipper declaring plants to be free from infection, countersigned by an inspector at shipping port; and while no definite agreement was come to, there was a consensus of opinion in favour of the Legislatures giving special powers to their respective Executives.

The papers read on educational subjects were: "Teaching Agriculture in High Schools and Colleges," by Mr. H. Deighton (Barbados) and the Rev. W. Caroll (Trinidad); "Teaching Agriculture in Elementary Schools," the Rev. J. E. Reece, Colonel Hicks, Mr. William Blair, Mr. Collens, Mr. Watkins and Mr. Hudson; "School Plots as Aids in Teaching Agriculture in Elementary Schools," Hon. W. Fawcett (Jamaica); "Experiment Station Work in Trinidad," Mr. J. H. Hart (Trinidad); "Aims and Objects of Experiment and Teaching Stations," Rev. Canon Simms (Jamaica). The subject of teaching agriculture in elementary schools was exhaustively treated. The paper by Canon Simms gave an interesting summary of observations on experimental stations and agricultural colleges in the United States of America and Canada during his recent tour, and very practical suggestions for higher agricultural teaching at Jamaica.

The Hon. Francis Watts, in his "Food Supplies of the Leeward Islands," gave a useful account of the food-growing resources of those islands; urged less importation of food-stuffs and more local production. He pointed out the close connection between cheap food and the abundant cheap labour so necessary in cane-growing countries, and brought forward evidence to show the "irrational" nature of the present diet, and how, by the proper combination of local products, it could be rendered "rational."

The Hon. William Fawcett (Jamaica) read an important paper on "Distribution of Economic Plants in Relation to Agricultural Development"; and other papers were read on "Steps taken at the St. Vincent Botanic Station for the Distribution of Seeds, Plants, &c., after the Hurricane of 1898," Mr. Powell; "Suggestions for Increasing the Usefulness of the Botanic Stations," Dr. Alford Nicholls; "Packing Seeds and Plants," Mr. J. H. Hart; "Bee-keeping in Jamaica," Mr. T. R. Doidge.

During the day the Chemical Section of the Conference presented a report upon uniformity in returning the results of field experiments on the sugar-cane, and upon some minor matters of detail.

A vote of thanks to the President, and the usual compliments, brought the conference to a close about 5 p.m. The representatives embarked the same night.

J. P. D'ALBUQUERQUE.

MODERN LIGHTHOUSE APPARATUS.

THE development of the modern system of lighthouse apparatus and illumination may be said to have originated in the mercury-float mechanism, devised in 1890 by the late M. Bourdelles, Director-General of the Central Lighthouse Service of France. Fig. 1 is a drawing of a lighthouse apparatus fitted with M. Bourdelles' mercury-float mechanism.

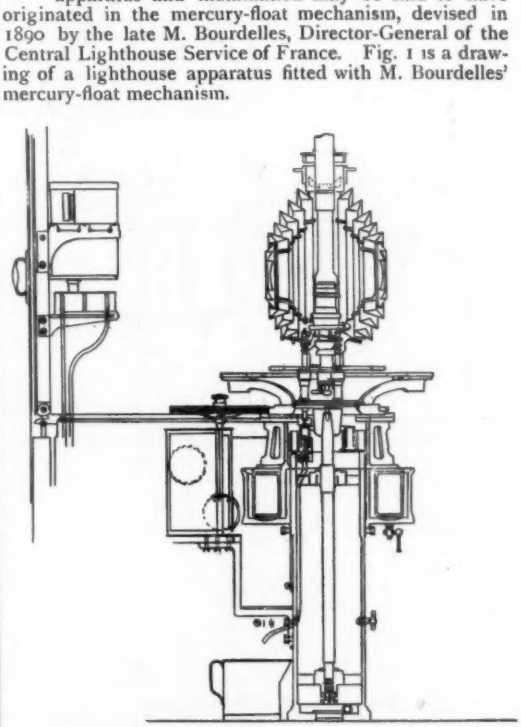


FIG. 1.—Feu-éclair. Third order apparatus. (Section.)

In place of the roller or ball bearings employed in the past for revolving apparatus, an annular trough is employed, in which there floats a second annular trough, on which is carried the dioptric apparatus. In order to steady the revolving superstructure, and to render it capable of a certain amount of adjustment, a vertical spindle projects downwards from the apparatus through the mercury trough to some distance below it, and is supported and guided upon suitable bearings.

Such is briefly the invention of the mercury-float mechanism, and it is clear that with only fluid friction to

contend with, the revolution of the apparatus is rendered easy in the extreme, and that a speed and steadiness of revolution is obtained that was impossible with the older forms of apparatus.

Having devised an apparatus capable of such rapidity of revolution, M. Bourdelles was led to the conclusion that by reducing the number of sides in a revolving apparatus, and so allowing of an increased size, it would be possible, with the rapidly-revolving mechanism, to produce flashes of great power, following one another at as short intervals as had been done with the old many-sided apparatus, and hence arose the *feux-éclairs*, or lightning-flash lights, now so generally employed.

This system, it will thus be seen, makes use of dioptric panels of the greatest possible amplitude, which are revolved at a speed limited only by the duration of flash

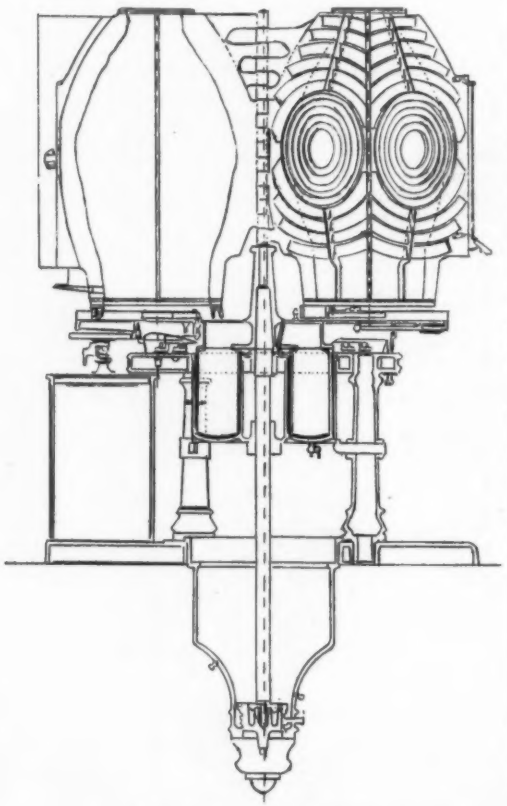


FIG. 2.—Feu-éclair. Twin apparatus.

necessary to give to the eye of the mariner the full perception of the light emanating therefrom. In practice this was found to be about 1/10 of a second for lighthouse purposes.

The first mercury-float *feu-éclair* light which was established was that at Senetose, in the Island of Corsica, in the year 1890.

As a further advance in lighthouse apparatus, the twin mercury-float *feu-éclair* may be mentioned. Fig. 2 is a drawing of this apparatus. Here, instead of the superposed biform, triform or quadraform apparatus previously used, the two apparatus are placed side by side, and are so set that the flashes from one apparatus are parallel to those from the other, so that at sea the beams are in effect one.

Following upon the single and twin *feux-éclairs* of M. Bourdelles come the spindle-eclipser apparatus of the writer. In this system only one—or at most two—dioptric lenses or panels are used in conjunction with an eclipsing device which periodically obscures and discloses the light. Figs. 3 and 4 are drawings of a single panel-spindle eclipser. The action of this form of apparatus is best explained by an example.

Suppose a group-flashing light is required, each group having two flashes; all that is required is to so design the mechanism of the eclipser that it will eclipse the light after two complete all-round flashes, remain closed for the length of time desired for the long dark period between the groups, and then open just long enough to allow the two flashes to be seen once more, and so on *ad infinitum*.

In place of only one panel two can be used; but here it is necessary to have the eclipser in two halves, each

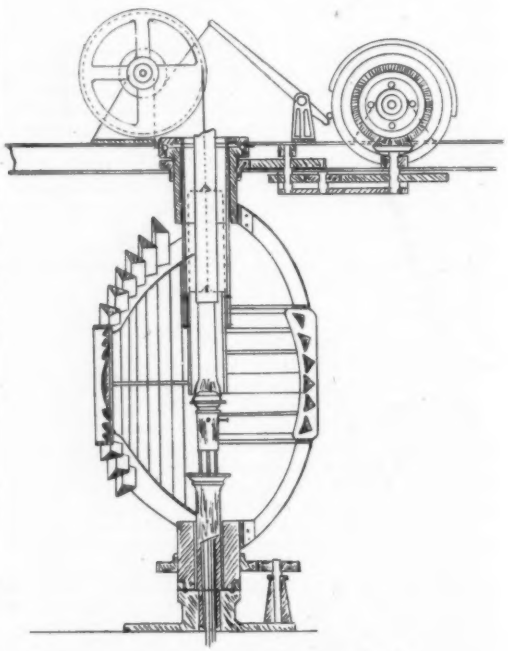


FIG. 3.—Spindle eclipsing apparatus. (Section.)

of which is operated separately, so as to obscure in rotation the light from one panel and then the next.

From what has been said, it is clear that with only one, or at most two, simple dioptric panels and an eclipse it is possible to produce all manner of group-flashing characteristics which in the past demanded the splitting up of the large panels into sections, from each of which a beam emanated. In the new system a complete panel, and that of the greatest possible amplitude, *i.e.* 180 in altitude, and azimuth can be employed, and consequently the most powerful flash is obtainable from this apparatus. As the apparatus do not need to be of large size, the method of mounting them upon upper and lower spindles has been employed merely to render their construction as simple as possible.

In addition to the improvements mentioned above, which deal with the actual lighthouse apparatus as a whole, there

are the improved types of lenses for lighthouse apparatus recently invented by Mr. Charles A. Stevenson, which he has termed the equiangular refractor, and that of the writer known as the inverse equiangular.

With respect to the smaller classes of lights, there are the new permanent lights burning for some weeks without the attention of a keeper, which are largely used in

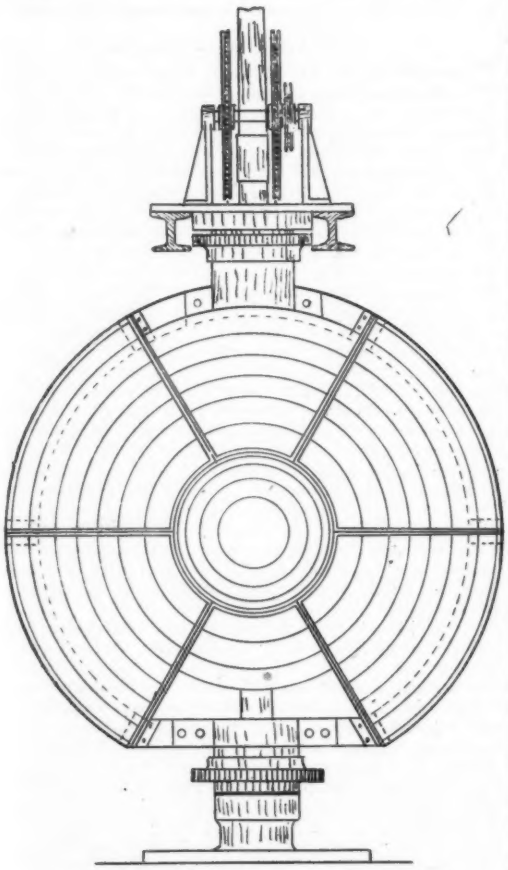


FIG. 4.—Spindle eclipsing apparatus. (Front elevation.)

the French Lighthouse Service. In these lights the upper portion of the wick is carbonised, so that no turning up or down thereof is necessary, and the supply of oil which feeds the lamps is of such a quantity and is so regulated that the lights burn without any attention whatsoever for many days. J. A. PURVES.

MR. BALFOUR ON SCIENTIFIC RESEARCH.

A SPECIAL festival dinner of friends of King's College, London, was held on Wednesday in last week, with the object of directing attention to the want of new laboratories, especially laboratories for physiological and bacteriological research, and promoting the collection of funds to supply the need. Mr. Balfour presided, and he made excellent use of the occasion by advocating the fuller recognition of the value of scientific research, and increased opportunities for carrying on original investigations. The encouragement of scientific research is a national responsibility, which has hitherto not been adequately realised either by the State, by public bodies, or by private individuals. Mr. Balfour's remarks, reprinted below, from the *Times*, will serve to remind people of the influence of science upon national progress and prosperity, and may thus lead to a more liberal provision of resources for assisting the advancement of natural knowledge.

We have all of us, probably, been stirred, either in making speeches or in listening to speeches, in recent years on the subject of technical education—a very loose phrase sometimes used, or misused, to mean education in manipulation or dexterity of hand treatment; sometimes, and I think more properly, used to mean that application of science or of the principles of science to industrial life, which we are more and more beginning to recognise is the increasing need of the age in which we live. It has been found easy, and I hope it always will be easy, to enlist popular interest in anything so useful as the application of scientific method to industrial pursuits. It will be all the more easy because of the fact that we have before us in certain countries striking and admirable instances of the success which attends, or may attend, such application of scientific method to industrial pursuits. An appeal for that purpose is an appeal which touches the heart of everybody nearly or remotely connected with the industries on which this nation as a whole lives, and on which it must continue to live if it is to live at all.

I appeal for something not less necessary, though for something perhaps more remote from the ordinary everyday popular educational interest; for I appeal on the present occasion, not so much for anything in the nature of technical instruction or applied science as for aid to carry out that instruction in science itself and those researches in pure science which lie at the base of that instruction which, from the very nature of the case, can only appeal indirectly and remotely to the great mass of mankind. And yet, after all, science is the essential matter that we have got to consider; its applications will come and must come, will come almost of themselves, must come in the course of time; but you cannot have applied science without having science in the first instance, and if you do not cultivate scientific research and scientific education, it will be in vain that you multiply your technical classes, it will be in vain that you labour to erect a great superstructure where your foundations have been so inadequately laid. I feel it the more incumbent upon me to urge upon you the claims and the glories of science pursued for itself from the fact that they cannot directly appeal to the general interest of the mass of mankind. We ought not to wonder, we ought not to criticise, and we ought not to be surprised that, among the great number of persons deeply interested and astonished at, for example, anything so interesting and sensational as wireless telegraphy, few remember the inventions which have made that telegraphy possible; they neither know of nor take interest in the investigations of a Maxwell or the experiments of a Hertz, which, after all, are at the base of the whole thing, without which any such discovery as wireless telegraphy would not have been possible, but who, as discoverers, had fame and recognition among scientific men capable of understanding their work, yet who have not, perhaps, even now that world-wide reputation, that currency in the mouths of men, which fall to inventors much less than themselves, who have properly built their work on the foundations laid for them by others. Yet to my view it is the bounden duty of every great place of University education that they should keep before them not merely the immediately practical needs of technical or other education, but that they should never permit the ideal of University investigation to be for one moment clouded in their eyes, or to lose interest, or cease to be the object of worthy effort and endeavour.

But that great object must increasingly, in my judgment, require the generous and liberal co-operation of all classes of the community, whether they be immediately interested in science, intimately acquainted with scientific details, or whether they be merely part of the general public. Men of science themselves are not always in a position to give that pecuniary aid necessary to establish the modern laboratory and to equip it with modern appliances; and they are right to call upon all those who take any interest in their subjects to aid them with that pecuniary assistance which in some other countries—many other countries—is extended to them by the Government, but which in this country, rightly or wrongly, by an almost immemorial

tradition, has been left chiefly to the energy of private enterprise. King's College will, without question, be one of the great teaching centres of the new London University. It requires at this moment, to enable it to carry out that great function, the assistance of the public to supply it with adequate scientific accommodation, especially, I am informed, in the matter of bacteriological and physiological laboratories and lecture-rooms; and it may be a matter of some consolation to those who take little interest in scientific matters, unless they can see their immediate application, that both bacteriology and physiology have a most immediate and direct bearing upon the life and happiness of mankind. In both branches of study King's College has proved itself rich in teachers of eminence. I am not going to discuss—it would be almost impertinent of me even to touch upon—the enormous interests bound up with the successful prosecution of these two great branches of research; but I may, perhaps, remind you of the enormous practical importance to us, of all people in the world, of some of the more recent researches in bacteriology. Bacteria are a very humble class of organisms, very unjustly abused, as far as I can discover, by ordinary public opinion, in which they suffer, as other classes suffer, by having among them a certain number of black sheep; but for the most part they are not only innocent, but most useful allies to industry, and almost necessary co-operators in some of those great functions which have to be discharged if the health of great cities is to be maintained. But, apart from that, no doubt our chief interest in them lies in the pathogenic members of the group, and we, of all people in the world, are especially interested in treating of those forms of tropical disease which they have produced, since we are engaged in maintaining a number of our population in countries where the diseases born of these bacteria are the greatest scourges. It is, perhaps, to a distinguished professor of King's College more than to any other man in this country that we owe some of the most useful discoveries in these matters. As the last speaker called attention to Mr. Chamberlain's great work in drawing together the bonds of Empire and knitting in closer unity the various elements that make up that Empire, so I may be permitted, in the wholly different subject with which I have to deal to-night, to remind you that he, as Secretary of the Colonies, has done his best to encourage these bacteriological investigations of which I, at all events, entertain such great hopes that science will soon be able to combat, by its discoveries, the inherent difficulties which have hitherto so greatly militated against Europeans in the tropical climates of the world.

WHAT LONDON SHOULD DO.

I do not know that it is necessary for me at greater length to impress upon you the theme which has been committed to my charge; but I confess I cannot conclude without admitting that I think this great city has been somewhat remiss in the support which it has hitherto given to scientific investigation in the commercial metropolis of the world. Technical education, if I may revert for an instant to that subject, has in it almost necessarily some element of competition. We hear it said Germany is doing this, France is doing that, some other country is doing the other, unless you keep abreast of them in your methods of education you will fall behind them in your industrial enterprises. That is a very proper argument; it is a very patriotic argument; it is an argument I myself have used before and shall use again; it is an argument I should think myself justified in using; but I am appealing to you on behalf of a case which has in it none of this element, this inferior and lower element, of competition whatever. Every scientific discovery, wheresoever it be made, be it made in Berlin, Paris, London, New York, Vienna, as soon as it is made is the common property of every man of science. Nations may erect against each other some barrier of tariffs, they may engage in some absurd rivalry animated by I know not what sort of suicidal policy; but men of science wherever they live, to whatever nation they belong, have a cause common to humanity at large, which knows no provincial boundaries, which is not interfered with by any sectional rivalries. To that great common fund of knowledge, the basis after all of your civilisation as it is, the basis after all of the industrial progress you propose to make, I think London should contribute its full share. London takes a well-earned tribute from every discovery made throughout the world for the advancement of civilisation; from all these some section of London gets the benefit. Let those who are dwellers in London feel that they have some obligation to the world at large corresponding to the great, the international position we occupy. Let us do what we can as a community to further that investigation into the secrets of nature, that storming of the citadels of natural knowledge in which all civilised men are, and ought to be, co-operators. Let it not be that, while there are great centres of scientific teaching in every other great metropolis, we have allowed ours for one moment to fall behind in the race.

GENERAL A. A. TILLO.

GENERAL A. A. TILLO, Vice-President of the Russian Geographical Society, who died at St. Petersburg on January 11, was the founder of an *exact* physical geography of Russia, based on correct scientific data. He was born in 1839, and received his education in the Constantine Military School, from which he was promoted officer in 1859. He completed next his education by passing through two military academies, artillery and General Staff, and worked for two years at Pulkova in the Geodetic Department of this last academy. In the years 1879–82, in his capacity as educator of one of the Russian Grand-Dukes, he followed lectures on mathematics in different West European universities, as also a full course of Law at the University of Strasburg. He began geographical work as the head of the surveys of the Orenburg region, by publishing a catalogue of latitudes and longitudes determined in that region, followed by a study of the distribution of magnetical elements, and by a description of the levelling made between the Caspian Sea and Lake Aral. His next works were "On the Byelgorod Magnetic Anomaly," "On the Present Condition of the Science of Terrestrial Magnetism," and "On the Yearly Amplitudes of Variations of Level in the Lakes of Russia," "On the Average Altitudes of the Continents in Both Hemispheres." Settling some five-and-twenty years ago at St. Petersburg, he began to work out in a most systematic way the different portions of a general physical geography of Russia. The surfaces of different parts of the empire having already been calculated by Strelbitzky, General Tillo measured first, with a very great accuracy, the lengths of the rivers of the Russian Empire, their gradients, and the surfaces of their basins, thus correcting many erroneous statements of his predecessors. Then, he worked for years in collecting all documents relative to the altitudes of European Russia, and finally published in 1889 his most remarkable hypsometric map of European Russia, on a scale of 40 miles to an inch, followed seven years later by the same improved map on a still larger scale (27 miles to an inch), in four sheets. This map, by showing the existence of three great depressions amidst the swelling of Middle Russia, completely altered the hitherto current conceptions as to the orography of European Russia. His next work was a most elaborate atlas of isobars in Russia and Asia altogether, and it was followed by still more elaborate works on the distribution of magnetic elements on the surface of the earth, "Variation séculaire et éphémérides du Magnétisme terrestre," "Loi de la Distribution du Magnétisme moyen à la Surface du Globe," "Atlas des Isanomales et des Variations séculaires," and "Tables fondamentales du Magnétisme terrestre," which won for Tillo a wide European reputation. His smaller contributions to the publications of the Russian Geographical Society were countless. He was a member of both the St. Petersburg and the Paris Academies of Sciences. His extreme modesty and willingness to undertake any amount of calculations to work out the results of observations made by explorers in Asia, made of him one of the most sympathetic figures in the Russian Geographical Society, in which he presided over the Physical Geography Section. A pamphlet containing an obituary notice of General Tillo, and a full list of his works, has just been published by this Society.

NOTES.

SIR GEORGE STOKES has been elected an Associate of the Paris Academy of Sciences.

WE learn that the name of Dr. William Osler, F.R.S., at present superintendent of the Johns Hopkins Hospital at Baltimore, is being mentioned in connection with the vacancy in the Chair of Medicine at Edinburgh.

AN extra meeting of the Chemical Society will be held on Thursday, March 8, when a lecture, "On Recent Researches on Nitrification," will be given by Prof. Warington, F.R.S. The chair will be taken at 8.30 p.m.

THE Paris Geographical Society has awarded its annual grand gold medal to Major Marchand, and silver and bronze medals to other members of his expedition.

ON the 28th inst. Mr. Robert H. Scott will retire from the post of secretary to the Meteorological Council. At the end of the year 1899 Mr. Scott had completed thirty-three years of service in the Meteorological Office, and for the last twenty-five years has acted as secretary of the International Meteorological Committee, which honorary position, we understand, he will continue to hold until the next meeting of that committee in September. Mr. W. N. Shaw, F.R.S., Fellow of Emmanuel College, Cambridge, and hitherto assistant director of the Cavendish Laboratory, and lecturer in physics in the University of Cambridge, has been appointed as successor to Mr. Scott. Mr. Shaw has been a member of the Meteorological Council since May 1897, and will continue to hold that position in addition to that of secretary.

AT the annual meeting of the Russian Geographical Society, on February 7, the great Constantine medal was awarded to A. M. Pozdyéeff for his work, "Mongolia, and the Mongols," and other works upon the same country; the Count Lütke's medal to L. K. Artamonoff for geodetical and geographical work in Caucasia, Persia, and Abyssinia; the Semenoff's gold medal to E. W. Brettschneider for his extensive work, in English, "History of European Botanical Discoveries in China"; the great gold medal of the Society to N. A. Marrusa for his collection of the parables of Wordan; and the Prjevalsky medal to E. E. Anert for his geological work in Manchuria. Three small gold medals were awarded to R. N. Savélieff for meteorological work, N. N. Lelyakin for astronomical calculations, and to V. N. Iochelson for a communication on the nomads of the tundras of North-east Siberia. It is interesting to note that the Semenoff silver medal was awarded this year to Madame M. A. Lyamina for her works popularising the results obtained by the Russian travellers, whose splendid full reports, published in stately quarto volumes, remain, as has often been pointed out in these columns, inaccessible to the general reader. Eleven more silver medals and five bronze medals were given to different persons for minor works.

THE death is announced of Dr. Hermann Schäffer, honorary professor of physics in the University of Jena.

THE March exhibition at the Royal Photographic Society will be provided by the National Photographic Record Association, and will be opened on Wednesday, March 7, by Sir Benjamin Stone, M.P.

DR. SCHWENDENER, professor of botany at Berlin, has been elected a correspondant of the Paris Academy of Sciences, in the section of botany, in succession to the late Baron F. de Müller.

THE meeting of the Physical Society to-morrow (February 23) promises to be of special interest. Prof. R. W. Wood, of the University of Wisconsin, U.S.A., is to describe his recent investigations in optics, and will exhibit some of the apparatus used in those experiments, together with photographs demonstrating the evolutions of reflected wave-fronts.

THE committee of the Athenæum Club, acting under the rule which empowers the annual election of nine persons "of distinguished eminence in science, literature, the arts, or for public services," have elected Dr. David Gill, C.B., F.R.S., Astronomer Royal at the Cape of Good Hope, a member of the Club.

AUSTRIAN geology has suffered a severe loss in the death of Mr. K. M. Paul, chief geologist on the Austrian Geological Survey, on February 10, at the age of sixty-two. While his chief work was the investigation of the geological structure of the Carpathians and of the environs of Vienna, his intimate knowledge of the geology of Galicia led to his being regarded as one of the leading authorities on the occurrence of petroleum.

THE anniversary meeting of the Geological Society was held on Friday, February 16. The officers were appointed as follows:—President: Mr. J. J. H. Teall, F.R.S.; Vice-Presidents: Prof. J. W. Judd, C.B., F.R.S., Mr. Horace W. Monckton, Prof. H. G. Seeley, F.R.S., and Prof. W. J. Sollas, F.R.S.; Secretaries: Mr. R. S. Herries and Prof. W. W. Watts; Foreign Secretary: Sir John Evans, K.C.B., F.R.S.; and Treasurer: Dr. W. T. Blanford, F.R.S. The medals and funds awarded, as already announced (p. 279), were presented. The President delivered his anniversary address, which dealt chiefly with the present state of knowledge regarding underground geology in the south-east of England.

AT a special meeting of the Manchester Literary and Philosophical Society, held on February 13, Prof. Horace Lamb, F.R.S., being in the chair, the Wilde Medal for 1900 was presented to Lord Rayleigh for his numerons and brilliant contributions to mathematical and experimental physics and to chemistry. A Dalton medal, struck in 1864, was presented to Sir Henry Roscoe, F.R.S., for his remarkable original researches in chemistry, and for his distinguished services to scientific education. The third award, which was to Prof. A. W. Flux, was that of the Wilde premium of fifteen guineas for two much appreciated papers on "The cost of sea transport in proportion to values of cargoes," and "The fall in prices during the past twenty years." After the presentation of the medals, Lord Rayleigh proceeded to deliver the Wilde lecture, for which he took as the subject, "Flight, Natural and Artificial."

WE learn from the *Electrician* that the late Prof. D. E. Hughes has bequeathed the sum of 2000*l.* for the foundation of a "David Hughes Scholarship" in connection with the Institution of Electrical Engineers. The text of that portion of the will which relates to the bequest is as follows:—I direct and declare that the legacy of two thousand pounds, so bequeathed to the said Institution of Electrical Engineers, of which I am Past President, shall be invested by them in any manner for the time being authorised by law for the investment of trust funds, for the purpose of founding in connection with that Institution a Scholarship Fund, to be called the David Hughes Scholarship Fund. And I direct that the annual income produced by the investments for the time being constituting the fund shall be given each year to a student preparing himself for the career of an electrical engineer, under conditions similar in all respects to those under which the fund now known as the Sir David Salomons Scholarship Fund is administered, but so that if and so often as for any reason the Scholarship hereby founded shall not be for any given year awarded to any student, the annual

income of the Fund for that year shall be invested in manner aforesaid and added to the capital of the David Hughes Scholarship Fund.

PROF. H. A. HAZEN, a prominent official of the U.S. Weather Bureau, whose name will be familiar to many readers of NATURE, was, we regret to learn, thrown from his bicycle on January 22, and died on the following day, from the injuries received. Referring to his lamented death, the *National Geographic Magazine* states that he was born on January 12, 1849, in Sirur, India, about one hundred miles east of Bombay, and went to America when ten years old. He graduated from Dartmouth College in 1871, and for some years after was instructor in drawing in the Sheffield Scientific School, New Haven, and later was assistant in meteorology and physics under Prof. Elias Loomis. He received an appointment in the U.S. Weather Bureau in May, 1881, being assigned to special duty on such problems as the investigation of the psychrometer and the proper exposures of thermometers, the study of thunderstorms, and other important questions. At a later period Prof. Hazen was assigned to duties of a broader aspect, including weather forecasting and occasional editorial work on the *Monthly Weather Review*. In addition to his official work in the Weather Bureau, Prof. Hazen was a frequent contributor to meteorological and other scientific journals. He was one of the supporters of *Science* during the years 1882-1889, and of the *American Meteorological Journal*, 1884-1886. Among his larger publications are the "Reduction of Air Pressure to Sea Level" and the "Climate of Chicago."

THE address which Dr. Morris delivered at the opening of the second West Indian Agricultural Conference, of which an account is given in another part of this issue, was a powerful exposition of the aims of the Agricultural Department, and of the success which had attended its efforts during the first brief year of its existence. It is gratifying to find that, with regard to the question of central factories, Dr. Morris gives the great weight of his approval to the representations made by the Barbados Agricultural Society in favour of the establishment of factories on the basis of a division of profits between the planters and the factory. Not the least interesting portion of the address is that dealing with agricultural education. The education which has drawn the Englishman from the soil at home, and so divorced him from agricultural pursuits that, even as an emigrant, he is only a settler in towns, has been copied in the West Indies; and the results, although not so evident perhaps in Barbados, have been identical. Dr. Morris shows that the aim of the Department will be to correct this system, not by refusing education to the agricultural masses, or by restricting their education to purely agricultural subjects, but by expanding the teaching now afforded at elementary schools, so as to embrace a large amount of valuable agricultural knowledge. The ultimate effect of the efforts of the Department in this direction must be the creation of a sturdy and intelligent peasant proprietary in the colony, most adapted to their requirements; whilst the supply of labour on the estates will be affected only in the improved value, not cost, of the labourer.

MANY attempts have been made to construct a compass which is independent of the permanent and transient sources of error to which a ship's compass is subjected. The latest device is the Evoy patent compass, which is so arranged that it can be placed in a position where it is not subject to the magnetism of the ship —that is to say, it is hauled up to nearly the height of the masts, where it is supported on the jumper stay. To determine whether the steering compass of a ship is showing the correct magnetic course, the Evoy compass is hoisted up aloft, given time to settle, and then brought down again, the reading of the steering compass being taken at the same time. It is obvious, however, that in the course of being lowered the overhead compass would come again within the magnetic influences of the ship, and thus be liable to have its reading disturbed before being inspected by the officer on duty. An automatic contrivance is therefore provided which locks the compass card as soon as the lowering is begun. Hence it is possible to check the indications of the compass on the bridge, exposed to the perturbing influences of the ship's magnetism, by those given by the Evoy compass high up beyond their reach. The instrument, which is mounted in such a way as to protect it from the effects of vibration and rolling, has been tested for some time on board a number of vessels, and has, it is stated, given satisfaction to the commanders.

THE recent falls of snow, which have been followed by heavy rains and rapid thawing, have led to disastrous floods in several parts of England. One lesson that is taught, is that homes (usually of the poor) should never be erected on alluvial ground In the *Standard* of February 17, we read that the river Avon at Bath has been greatly swollen, and in the low-lying parts of the city people have been driven into the upper rooms, and have had to be supplied with food by means of boats. Interesting and yet deplorable are the records of the floods in South Devon. The thawing of snow on Dartmoor, accompanied by twenty-four hours' continuous rain, rapidly swelled the waters of the river Dart, and the outflow was checked by high spring-tides. Consequently (as stated in the same newspaper) the alluvial meadows were soon submerged, the floods being the highest within living memory. Many hundreds of sheep, horses, pigs, and other live stock were washed away by the force of the current. From one farm on the borders of the Dart no less than 232 sheep were drowned, and the banks were strewn with dead animals, trees, and other débris. We learn also that at Guildford the ancient town bridge has been completely carried away by a big baulk of timber, which was brought down by the flooded river Wey, from a neighbouring timber-yard.

A BILL for taking the census in Great Britain in 1901 was read for the first time in the House of Commons on Monday. The subject of census-taking and its limitations was brought before the Royal Statistical Society at the meeting on Tuesday, by Mr. J. A. Baines, who pointed out that the main interest of the census from the statistical standpoint lies, of course, in the schedule. The attempt to make the census the vehicle of a plebiscite on any matter of opinion, whether of temperance, volunteering, the empire, or such like, is foredoomed to failure, and tends to discredit the rest of the inquiry. Purely personal facts, such as sex, age, marriage and birthplace are the most important questions, and, luckily, the easiest to answer correctly. On the other hand, they are those which, in the mass, tend to vary more quickly in this country than any others. It is imperative, therefore, that for practical statistical work we should have the two first, at least, revised at more frequent intervals than ten years, and the Statistical Society has fortunately the co-operation of actuaries, sanitary officers, economists, and all social investigators in pressing upon the Government the need of either a permanent quinquennial Census Act, or, at least, the prescription of a quinquennial enumeration in the Bill now under consideration.

PROF. E. H. BARBOUR, professor of geology in the University of Nebraska, has recently given reasons for believing that a rapid decline of geyser activity is taking place in the Yellowstone National Park. If the present rate of decline continues, it seems possible that within a decade many of the well-known geysers will have died out. As a result of an examination of the geyser area, after an interval of four years, Prof. Barbour gives the following instances among others of the

diminution of activity which has occurred: The Fountain Geyser, which was such a favourite that the Fountain Hotel was situated at that spot, is now wholly extinct, and a very inferior substitute named the Dewey Geyser has taken its place. The Cascade Geyser, another favourite because of the frequency of its eruptions (about every fifteen minutes), has dropped to an eruption interval of once every twenty-four hours. The Grand Geyser, which used to burst out once a day, was only active three or four times the past season. The Beehive Geyser, active in 1895, is supposed to be wholly extinct. Old Faithful seems as fine as ever, but the interval of eruption is now about seventy-five or eighty minutes instead of once an hour. If it is possible to judge fairly of such matters, there seems to be increasing activity in the ebullition of the water in that greatest of geysers, the Excelsior, which leads to a feeble hope that it may possibly be rejuvenated yet once again. An apparent increase in the activity of the Mud Geyser has also been remarked; but in spite of these cases, on the whole it appears that a distinct decline of activity is taking place.

THE Meteorological Council have just issued a discussion of the diurnal range of rain at the seven observatories in connection with the Meteorological Office, for the years 1871–90. The tables show, *inter alia*: (1) the total monthly and yearly amounts for each hour; (2) the average hourly rainfall for one day in each quarter, and for the whole year; and (3) the frequency of its occurrence for each hour, expressed in percentages; and the tables are accompanied by diagrams. England is represented by three stations—Falmouth, Stonyhurst and Kew; Scotland by two—Glasgow and Aberdeen; and Ireland by two—Valencia and Armagh. The year, as a whole, does not exhibit any well-defined distribution of quantity. The western observatories show that the heaviest rains occur in the early morning, and that the least rain falls in the early afternoon; while the inland and eastern observatories show that the heaviest rains fall in the afternoon. The frequency with which rain falls at the different hours of the day gives more regular results than can be obtained from the hourly distribution. The general conclusion drawn by Dr. R. H. Scott, who has carried out this useful investigation, is that everywhere in the British Islands the forenoon hours, from about ten o'clock, are drier than the rest of the day, and that although the temperature has not then nearly reached its maximum, invalids would be less likely to get wet if they went out in the morning. In the neighbourhood of London, however, there is very little evidence at any season of the year of a maximum frequency of rain.

A DESCRIPTION of an aluminium cable used by the Hartford Electric Light Company as a three-phase line, to convey the current over a distance of more than eleven miles, is given in the New York *Electrical Review*. This is another case in which aluminium has been successfully used as an electrical conductor. The trial stage is now passed, and aluminium conductors have been proved to stand the test of practical working under many different conditions, and for continued periods of time. The high price of copper is responsible for the increased use of aluminium as a substitute for it. The difference in specific gravities between copper and aluminium is as 1 : 3·33 and with a conductivity of 60 per cent. that of copper, there is an actual difference in weight between an aluminium and a copper line of about 50 per cent. This fact was very noticeable in putting up the Hartford wire, it being very much more readily handled in the stringing. An objection has been raised to the use of aluminium from the fact that the diameter is necessarily increased. This is true, but in ordinary circumstances an increase of 20 per cent. in the diameter of a conductor is not of great importance, and the objection applies only to conductors that are carried in ducts or conduits where space is necessarily limited. Official tests have been made under the direction of the Hartford Electric Light Company's experts, and the guarantees have been fully equalled, and in some cases exceeded. The line has worked perfectly from the time the generators were started, and has been accepted by the company. Some of the American plants equipped with aluminium wire are carrying much higher voltages than this particular line, which was constructed for 20,000 volts.

A USEFUL paper by Mr. H. N. Dickson, entitled "The mean temperature of the surface waters of the sea round the British coasts, and its relation to the mean temperature of the air," was recently communicated to the Royal Meteorological Society (*Quarterly Journal*, vol. xxv. No. 112). The paper was based on observations taken during eighteen years, 1880–97, at the instance of the Meteorological Council, with the co-operation of the Coast Guard and the various Lighthouse authorities. The observations, which were taken about sunrise and 4h. p.m., have been carefully sifted by Mr. Dickson, and the monthly and yearly averages calculated, tabulated, and plotted on small charts. The extent of the daily range appears to depend on local conditions, such as the speed and duration of tidal streams, the extent of shallow water, &c. The stations on the west coast give a daily mean range for the year of 0°·7, those in the North and Irish Seas give a daily range of 0°·8. With regard to the yearly distribution of temperature, the average at the entrance to the English Channel is about 54°, on the south-west of Ireland 52°. The mean of 49° persists along the north coast of Ireland and the west coast of Scotland to Stornoway. After leaving the Straits of Dover the mean falls to 50° off Suffolk and Norfolk, declining to 48° off the coast of Northumberland, and to 47° at the Orkneys and Shetlands. A comparison of the mean annual temperatures of air and sea shows that the mean excess of sea over air never exceeds 2°; a difference of 1°·7 is only reached or exceeded off the west coast of Ireland, and the south-east coast of England. On the south coast of Ireland, south-west of England and the extreme north of Scotland, the difference is about 1°; in the Irish Sea and the east coast of Scotland about 0°·5, and on the east coas of England still less. One important conclusion drawn by the author is that the mere presence of Atlantic water is more effective in depressing the summer temperature than in raising that of the winter months. Apart from the value of the paper as a contribution to climatology, it will be of special importance in investigations connected with questions of fisheries.

IN the *Physical Review* for December 1899, Mr. E. H. Loomis describes experiments on the freezing points of solutions, conducted with the object of testing the validity of the van 't Hoff constant for dilute aqueous solutions of non-electrolytes. The method of determining the freezing points of dilute solutions is one introduced by the author in 1893, and has been used to find the molecular depressions of a large number of non-electrolytes in aqueous solution, and it is found that the van 't Hoff constant is exactly verified in all cases examined, except methyl-alcohol, ethyl-alcohol and ether. The experimental value is found to be 1·86.

A REPORT on units of heat, drawn up by E. Warburg for the Naturforscherversammlung in Munich of September last, has been reprinted by Johann Ambrosius Barth, of Leipzig. The report deals with the absolute units, the erg and joule, and their relations with practical units, viz. the "calories" in which water at 0° and at 15° are taken respectively as standards, and the mean water-calorie between 0° and 100°, also the temperature-variations of the specific heat of water, especially in the neighbourhood of its maximum.

PROF. J. MASSAU, of Ghent, sends us a lithographed paper on the graphic integration of partial differential equations. It is divided into three chapters, dealing with integration by elements, integration equations of the first and second orders and of simultaneous linear equations by means of characteristics, and applications to variable motion of fluids, under which latter heading may be included finite wave-motion, and the formation of bores. A somewhat analogous problem, viz. the approximate integration of partial differential equations of the first order of the form $p+qf(x,y)=0$, subject to the condition that $f(x,y)$ is real, finite, single valued, and continuous in an assigned region C, and that q is also continuous, is treated by Dr. C. Severini in the *Rendiconti del R. Istituto Lombardo*, xxxii. 19, 20, who shows that the integral of the equation can be represented to any degree of approximation by means of a rational integral polynomial in x and y.

STIMULATED by the disastrous Constantinople earthquake of July 10, 1894, the Sultan of Turkey ordered that observations of earthquakes should be regularly made within his empire, and the Director of the Meteorological Observatory was fortunate enough to secure the assistance of Dr. G. Agamennone, of Rome (*see* NATURE, vol. lii. p. 4). During the years 1895 and 1896, this well-known seismologist created an organisation for the collection of earthquake records over the whole of the south-east of Europe and Asia Minor, and the results for 1895 and the early part of 1896 were published in monthly bulletins, issued by the observatory. For reasons, which are unknown, the authorities refused to continue printing these valuable lists, and, on the departure of Dr. G. Agamennone, the whole organisation was allowed to lapse. Fortunately, a copy of the records for 1896 was preserved, and has recently been published in Gerland's *Beiträge zur Geophysik*. This valuable paper contains a list of more than 400 earthquakes, as well as detailed descriptions of the more important shocks. It is a monument of what can be accomplished, even in a semi-civilised country, by the energy of one man.

DR. D. G. ELLIOT is continuing his studies in North American mammals in the *Publications* of the Field Columbian Museum; the last part with which we have been favoured treating of collections from Oklahoma and Indian Territories. A feature of Dr. Elliot's is the attention bestowed on the habits of animals, the present part describing the nests of the wood-rats (*Neotoma*).

TO the *Memorias de la Sociedad Cientifica "Antonio Alzate,"* issued at Mexico, Prof. R. Manterola contributes a paper on longevity in connection with mental work. The author divides professions into three groups, according to their influence on longevity; and it may be satisfactory to scientific workers to learn that they occupy a high position in the most favoured group. In mental workers the general average of life is stated to be above 68 years, and the average of men of science, lawyers and historians more than seventy.

IN the December number of *Natural Science*, Mr. Barrett-Hamilton draws an interesting parallel between the occurrence of portions of the skin of the "last of the Ground-Sloths" in Patagonia, and of similar remains of Lemmings in a Portuguese cave. The latter animals are now unknown south of lat. 58° 30′, yet the Portuguese remains present the appearance of having belonged to animals recently dead. The inference is that even in comparatively damp climates, the shelter of a cave, with abundance of dry dust, is sufficient to preserve some of the soft parts of animals for very long periods.

WE have received from the trustees of the Indian Museum, Calcutta, a newly published "Guide" to the collection of fishes exhibited in what was formerly the library of the Geological Survey. Dr. A. Alcock is the author of this useful little pamphlet, which not only contains a well-written dissertation on the structure of fishes in general, as well as a classified synopsis of the families, but has a special section on the geographical relations of the marine fishes of India. Among the exhibits are models of deep-sea fishes; and it may be suggested that a similar series would be of great interest if added to our own national collection.

IN the February issue of the *Quart. Journ. Microscop. Soc.*, Mr. J. P. Hill, of Sydney, continues the account of his important researches into the embryology of the marsupials. His discovery of the existence of a distinct placenta in the Bandicoots (*Perameles*) will be fresh in the minds of our readers, and likewise the inference that the retention of such a structure indicates a primitive condition. His subsequent investigations have led the author to the significant conclusion that the urino-genital organs of the Bandicoots are in a condition which may be described as persistently embryonic, and thus much more primitive than in any other known marsupial. Accordingly, all the available evidence points to the view that the marsupials originally developed a placenta, which has been aborted in the more specialised forms. The second part of the present communication deals with the fœtal membranes of one of the Wallabies.—To the same journal Mr. H. M. Bernand contributes a paper on the structure of the retina of the eye in the Amphibia, in the course of which he is led to conclude that the so-called "cones," in place of being important sensor organs, are nothing more than stages in the development of new "rods."

IN these columns mention has already been made of the discovery of a horn of the extinct Aurochs or Ur (*not* the Bison) in a peat bog in Lower Pomerania. This remarkable specimen Dr. Nehring now describes and figures in the *Deutsche Landwirtschaftliche Presse* of February 10. In the course of this article the author mentions that the Aurochs (of which our domestic cattle are the descendants) survived on the Continent till 1627, and that examples of its enormous horns, sometimes mounted as drinking-cups, were preserved in many inns, churches, and castles, especially in South Germany and Alsace-Loraine, till a comparatively recent date. In 1550 Conrad Gesner, for instance, mentions having seen skulls, with the horns, of Aurochs at old hostels in Worms and Mayence. Till as recently as the first French Revolution, two Aurochs' horns were preserved in Alsace, the one in the cathedral at Strasburg, and the other in the cellars of the episcopal palace at Zabern. The first measured 6½ feet in length, while the second held four litres. Since both are now lost, the newly-discovered sub-fossil specimen is of priceless value.

IT appears from the annual meeting, on January 28, of the Russian Institute of Experimental Medicine (Pasteur Institute) that its activity is steadily developing. The number of its provincial branches has been increased this year by a branch opened in Transbaikalia for the study of rinderpest in East Siberia. More than fifty papers, some of which are of great value, have have been read at the meetings by Drs. Nencki, Pavloff, Vinogradski, Semenoff, Lukianoff, Vladimiroff, Dzerzgowski, Schultz, and their pupils. The most important of them was perhaps the paper, read by Prof. A. M. Lévin at the annual meeting, on the bacterial origin of scurvy. No less than 80,000 scurvy patients were registered last year in the provinces which had suffered from famine (755,000 for the last eleven years). The epidemical character of scurvy became well established by the last few years' observations, and Prof. Lévin eventually obtained pure cultures of the bacteria of scurvy. They have the shape of rods, with rounded ends, have no cilia and give no spores. They are similar to diplococci, and belong to the group of bacteria which are well known as the cause of chicken-

cholera. Scurvy would thus appear "as a chronic form of this latter disease." During the last year the Institute was also very active in preparing malleine and tuberculine (30,000 bottles), anti-diphtheria serum (33,000 bottles), anti-plague serum (8220 cubic centimetres), anti-plague lymph (400,000 c.c.), and various bacteria-cultures (about 1500). Anti-rabic treatment was resorted to in 745 cases, and the grand total of all deaths amongt this large number of patients was only 1 per cent. The Institute has had this year at its disposal a total of 35,000*l.* (350,000 roubles). The subscriptions for a monument to Pasteur now reach a total of 1400*l.*

THE present status of rice culture in the United States is reported upon by Dr. S. A. Knapp in *Bulletin* No. 22 of the U.S. Department of Agriculture (Division of Botany). The United States at present produces about half the quantity of rice consumed. In the case of other cereals, an enormous supply is exported. In the introduction to Dr. Knapp's report, Mr. F. V. Coville points out that this anomalous condition is due to the fact that rice, in addition to its tropical or subtropical character, is a crop grown chiefly on wet lands, where it has hitherto been impossible to use harvesting machinery. The crop must therefore be cut with a sickle, and American hand labour has been thrown into competition with the cheap labour of the tropics, a competition that has not proved profitable to the American. A new system of rice culture has, however, been developed in south-western Louisiana, by which, as now perfected, the elevated and normally or periodically dry prairie lands are flooded by a system of pumps, canals, and levees, and when the rice is about to mature the water is drained off, leaving the land dry enough for the use of reaping machines, shown at work in the accompanying illustration. Under this system the cost of harvesting, and therefore the total cost of productions

Harvesting Rice in South-Western Louisiana.

have been greatly reduced and the industry has undergone a rapid development. It was found, however, that a large proportion of the grains were broken by the steam-reaping and thrashing machines; so the U.S. Department of Agriculture appointed Dr. Knapp as an agricultural explorer, with instructions to visit Japan, investigate the rices of that country, and purchase a stock suited to meet the requirements of the American problem. Dr. Knapp returned in the early spring of 1899 with 10 tons of Kiushu rice, which was distributed to experimenters in south-western Louisiana and elsewhere in the rice belt. The result of the milling tests are now awaited. If the high milling quality of the Kiushu rice is maintained under the new cultural conditions, the last apparent obstacle to the complete success of an American system of rice cultivation will be removed. The action of the Secretary of the Department of Agriculture in thus making an attempt to improve an industry by a scientific examination of the conditions of cultivation is one of many similar examples of a far-seeing policy.

UNDER the title "The Nature and Work of Plants," Messrs. Macmillan and Co. are about to issue a simple introduction to botany, by Dr. Macdougal. It aims at explaining, in a way that beginners can easily understand, the purpose of a plant's different organs, the conditions of plant-life, and the effect of it on other forms of life.

THREE characteristic letters from De Morgan to Sylvester, written in 1856, when Sylvester was professor of mathematics at the Royal Military Academy, Woolwich, appear in the January number of the *Monist*, with an introductory note by Dr. G. B. Halsted.

A COPY of the eleventh issue of the annual volume on the wealth and progress of New South Wales, by Mr. T. A. Coghlan, Government statistician, has been received. The volume runs into nearly eleven hundred pages, and is full of interesting information concerning the natural resources, development, and present position of the Colony.

THE Geological Photographs Committee of the British Association have issued a circular announcing that they are prepared to undertake the reproduction, in platinotype prints, or as lantern slides, of a number of the views in their excellent collection. Such a set of pictures would be of great value to lecturers, teachers and students, both at schools and at higher educational institutions. Curators of museums, also, would find in the pictorial epitome of British geology which the illustrations would furnish, a very appropriate and instructive decoration. Prof. W. W. Watts, Mason University College, Birmingham, will send particulars of the scheme to any one who wishes to have them.

"WILLING'S PRESS GUIDE," or 1900, is a useful list of British, Colonial, and foreign newspapers and periodicals, classified under various heads for convenience of reference. In the classification according to interests, professions, trades, religious denominations, sciences and other subjects, we notice one or two curious entries. For instance, the "Astronomical Observations of the Cambridge University Observatory" and "Astronomical Observations and Researches made at Dunsink" can hardly be designated periodicals. Under the heading of Science, we find *Science and Art*—which has long ceased to exist—a journal of a local scientific society, the Report of the British Association, and a college magazine, but NATURE is omitted, though, we hasten to add, it is included in the alphabetical list. With the exception of this misleading classification of scientific publications, the "Guide" is a well-arranged book of reference to the newspaper press.

THE "Catalogue of Nests and Eggs of the Birds of Australia," by Mr. Alfred J. North, Ornithologist to the Australian Museum, which was published by the Trustees of the Australian Museum in 1889, as No. 12 of their series of Catalogues, is now out of print, and the Trustees have decided to issue a new work in an enlarged form by the same author. There will be representations of about 600 eggs on thirty full-sized plates, and arrangements are being made to have them hand-coloured for those who desire it. Some of the nests and breeding haunts of the birds will also be shown on full-sized plates, but the greater number will be interspersed among the text, where also a large number of the birds themselves will be figured. The photographs, from which the plates representing the nests are made, have mostly been taken by the author personally, many of them *in situ*, and show the actual surroundings of the birds' homes. The black and white drawings of the birds are by Mr. Neville Cayley, so well known for his life-like drawings and paintings of birds. The letterpress will contain descriptions of the birds, their nests, eggs and haunts, and an account of their life history. The

preparation of the plates is now well advanced. The work will be issued in parts as fast as the letterpress can be got ready.

VIOLURIC acid has already been utilised in calorimetric investigations in support of the ionic hypothesis, and in the current number of the *Berichte* another physical constant, the electrical conductivity, of this acid now gives rise to some interesting speculations by Prof. Abegg, as to the changes preceding ion formation. Starting with the experimental work of Guinchard on the conductivity, and applying the well-known van 't Hoff formula, the heat of dissociation of violuric acid is determined from the temperature coefficient of its dissociation constant, the values being −3970 calories between 0° and 25° C., and −3470 between 25° and 35° C. This is about ten times the usual order of magnitude for acetic acid and most of the other weak acids, and hence leads to the very plausible assumption that here, as in other cases, the greater part of the heat of dissociation is absorbed in intramolecular reactions which precede the formation of the ions. In support of this is adduced the high value found for the heat of dissociation of hydrofluoric acid (−3550), as compared with the values for the other halogen acids. Here the molecules are known to be H_2F_2, giving first HF molecules, and finally ions. Water behaves similarly.

THE anomalous value obtained for the atomic weight of tellurium, when viewed from the standpoint of the Periodic Law, has led to numerous experimental researches upon this constant. The value found has usually been higher than Mendeléeff's generalisation requires, and some observers have suggested that ordinary tellurium may contain two substances. The February number of the *American Chemical Journal* contains a contribution to this subject by Messrs. Norris, Fay and Edgerley, in which, as a preliminary to atomic weight determinations, the preparation of pure tellurium was attempted. By making use of the properties of basic tellurium nitrate, a metal was obtained free from silver, gold, bismuth, arsenic, antimony, and selenium, a specially delicate method being devised for the detection of traces of the last named. The double chloride of tellurium and potassium was then selected for careful study, being subjected to a series of fractional crystallisations, but no want of homogeneity could be detected in this way. Further attempts are being made upon the dioxide.

THE additions to the Zoological Society's Gardens during the past week include a King Vulture (*Gypagus papa*) from the Rio Purús, presented by Mr. H. A. De Lisle; a Weka Rail (*Ocydromus australis*) from New Zealand, a Common Snake (*Tropidonotus natrix*, albino), British, deposited; two Purple-capped Lories (*Lorius dromicella*) from the Moluccas, purchased.

OUR ASTRONOMICAL COLUMN.

COMET GIACOBINI (1900 *a*).—This comet has been observed several times since its discovery at the Nice Observatory, but its faintness will only permit of its observation with the largest instruments. M. Javelle estimates it to be of the 13th magnitude. A telegram received from Kiel on February 19 gives the following position:—

R.A. 2h. 22m. 3s. } 1900 February 17d. 8h. 2·5m.
Decl. −1° 19′ 27″ } Nice Mean Time.

The comet has continued its north-westerly movement from Eridanus, the above position being nearly between the stars δ and ο Ceti (Mira).

NEW MINOR PLANET (1899 E.Y.).—Recent observations of this planet have enabled Herr Otto Knopf, of Jena, to revise his elements and ephemeris, and he gives the new computations n the *Astronomische Nachrichten*, Bd. 151, No. 3621.

Elements for 1900 *January* 0·0, *Berlin Mean Time.*

M =	19° 43′ 24″·0
ω =	322 58 41·4
Ω =	89 55 39·0
i =	15 13 23·9
φ =	4 28 33·5
μ =	668″·1835
log *a* =	0·483407

Ephemeris for 12*h. Berlin Mean Time.*

1900.	R.A.	Decl.
	h. m. s.	° ′
Feb. 23	4 22 32	+20 53·5
27	25 43	21 16·0
Mar. 3	29 13	21 38·1
7	32 58	22 0·0
11	37 0	22 21·6
15	41 16	22 42·7
19	45 46	23 3·3
23	50 29	23 23·3
27	55 24	23 42·5
31	5 0 31	+24 1·1

HARVARD COLLEGE OBSERVATORY.—In presenting the fifty-fourth annual report of the Harvard College Observatory, Prof. E. C. Pickering, the director, supplies evidence of an unusually large output of work during the past year. With the photometer mounted on the east equatorial, over twenty-nine thousand measures have been made by Prof. O. C. Wendell, including the photometric measurement of Jupiter's satellites while undergoing eclipse, of the planet Eros, and of variable stars of long period. The west equatorial has been employed for visual examination of variables and comparison stars. Good progress has been made with the reduction of the transit observations made by the late Prof. Rogers in the years 1879–1883.

The new 12-inch horizontal meridian photometer has been used in place of the old 4-inch instrument, which is now in Peru. The director has made with this instrument 65,200 photometric settings on 120 nights, and after the year's trial the instrument has proved extremely satisfactory in practice, it being found that stars as faint as the 13th magnitude can be measured at the rate of one a minute, with an error of only about one-tenth of a magnitude.

Under the Henry Draper Memorial, 744 photographs have been obtained with the 11-inch Draper telescope, and 2395 with the 8-inch. The examination of the spectra on these plates has led to the discovery of 23 new variables, 15 of which showed *bright* line spectra.

At Arequipa, in Peru, 686 photographs have been obtained with the 13-inch Boydon telescope, and 693 with the 24-inch Bruce doublet. It is hoped that the plates of Saturn taken in August 1899 will furnish more accurate data for the orbit of the recently discovered ninth satellite.

At the Blue Hill Observatory the work has been practically confined to obtaining automatic meteorological records of the upper atmosphere by means of kites. The average height reached by the meteorograph was 9650 feet from the ground.

Prof. Pickering makes special mention of the serious consequences to the work of the Observatory which may ensue, owing to the continued fall of interest on the invested capital of the institution.

INTERFERENCE METHOD OF MEASURING SMALL DIAMETERS.—The *Bulletin* of the French Physical Society, No. 143, contains an account, by M. Maurice Hamy, of the application of interference-bands to the measurement of diameters of small celestial bodies. The method, originally suggested by Fizeau in 1868, was put to the test by Stephan in 1873, and has been used by Michelson in 1892, who determined the diameters of Jupiter's satellites with a 12-inch equatorial by this means. M. Hamy's improvement consists in substituting broad slits, allowing more light to pass than the narrow openings employed in previous experiments. For the solution of this problem a suitable formula has been found. The calculated diameters of Jupiter's four principal satellites agree remarkably well with the numbers found by Michelson, and M. Hamy's estimated apparent diameter of the plant Vesta, viz. 0·54″, is exactly the value found by Barnard by micrometric observations with the Lick equatorial.

ON DESERT SAND-DUNES BORDERING THE NILE DELTA.[1]

THE distribution of desert sand-dunes in the neighbourhood of the Nile Delta is remarkable. They form a fringe to the desert (where the latter supplies a suitable sand), the material being piled up in dune-tracts, or dune-massifs, wherever its flow is locally checked by ground moisture. The water seeps up through the sandhill, keeping it moist and compact nearly to the surface. The ground plan of the dune-massif has little relation to the wind, which, however, playing upon the surface, throws it into waves. A typical example of the progressive development of their form appears to be as follows. First, a gently-rounded swell, then the lee side becoming rather steeper and the summit of the swell no longer central, but nearer the lee side: the eddy under the lee slope gathers strength and begins to undercut the bank of sand, causing it to slip, forming a straight cliff. This process continues until the eddy has cut back to the summit of the growing dune, which is then of nearly equal average steepness on windward and on lee side. The windward side is, however, a smooth curve of compact sand, whereas the lee side consists of two portions, the upper a straight cliff of loose sand, the lower a curved surface of tolerably compact sand. It is common to find the central portion of a dune showing the fully-developed, the ends the embryonic form. Where the eddy cuts down to a hard bed, the slipping cliff may constitute the whole of the lee slope.

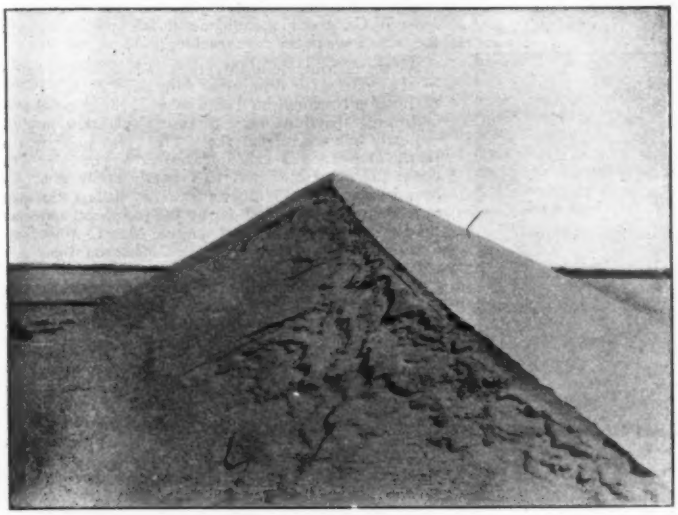


FIG. 1.—Pyramidal Dune.

The ratio Length/Height of blown ripples of sea-shore sand (which the author found to be about 18 : 1) holds equally for desert sand. Where, however, the air has an upward motion relatively to the surface, the ripples appear to be somewhat steeper, their front is less regular, their crest more nearly central, and they grow to greater amplitude, chiefly by excavation. A tract of small but perfect dunes (formed by the wind blowing upon dried Nile sand) was examined in order to see if there were any systematic connection between height and length, such as exists in blown sand ripples. The individual transverse ridges were markedly undulating, and, the low portion of one ridge not corresponding with the low portions of the succeeding ridges, it was evident that there was no such simple relation of Length/Height as in the case of ripples. A line, however, having been marked out in the up-and-down-wind direction across twenty-three of the small dunes, it was found that the *average* ratio Length/Height along the line was identical with that of the ripples. Wherever a depression occurs, the wind is concentrated, and the depression tends to increase. On the other hand, wherever the amplitude is slightly greater, the eddy is stronger, and increases the amplitude. The measurements show that in these dunes the two processes proceeded at the same rate. Although in this sense equal and opposite, the two processes combine to produce modification of form. Thus, the sweeping round of the sand from two depressions leaves the bare ground on leeward of the intervening part of the ridge surrounded by sands of such shape that the pit looks like the hoof-print of a giant horse. These are the structures known as Fuljes, the origin of which has been much discussed. If the wind continue with diminishing supply of sand, the crescentic dune called Barchan would remain, the windward slope of the Fulj being the lee slope of the Barchan. Barchans, however, are not necessarily, nor usually, formed in that manner.

The author describes the operations of the Suez Canal Company in planting *Casuarina* trees to arrest the drift of sand which at present finds its way into the canal. The *Casuarina* does not require rain, and its roots are capable of drawing moisture from a considerable depth. Indifferent as it is to drought, it can endure with equal indifference an excess of water at its roots, an important matter in the Government plantations on the west of the Delta, where periodical inundation has to be reckoned with. The *Casuarina* grows rapidly, and at Ismailia has attained a height of nearly sixty feet in twenty-five years. The foliage is light and feathery, waving confusedly and cheating

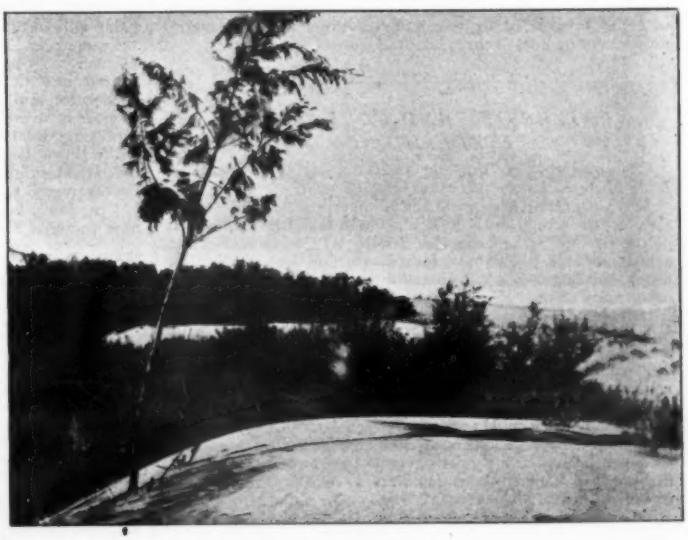


FIG. 2.—*Casuarina* Plantation.

[1] Abstract of a paper read before the Royal Geographical Society, Nov. 29, 1899, by Mr. Vaughan Cornish, published in the *Geographical Journal*, Jan., 1900. The illustrations are reproduced from the *Geographical Journal*.

the wind of its force. It is anticipated that the long lines of plantation bordering parts of the Suez Canal will check the drift of the sand from the west, causing it to pile up in a rampart parallel to the canal. The trees should live and grow even when nearly buried in sand, being nourished by the water at their roots.

The largest of the dunes described by the author are those bordering the old Pelusiac branch of the Nile, eastward of the Suez Canal. The height of these dunes is reckoned at 300

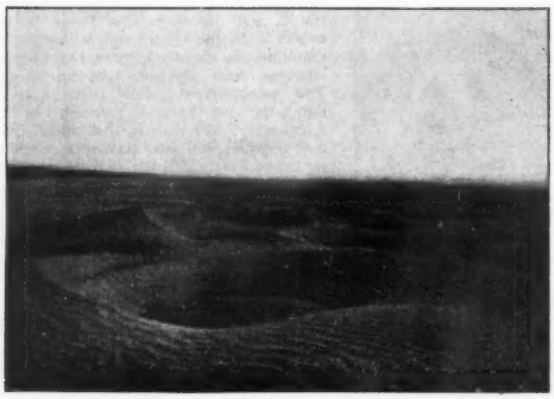


FIG. 3.—A Fulj.

eet and upwards. Once enveloped within the labyrinth of sandhills, however, the dimensions appear to be much greater. Under a low sun the scenery is especially remarkable. The startling contrast of light and shadow, the absence of detail on the smooth surfaces of pure blown sand, the steep slopes and bold forms, together with great clearness of definition and a death-like stillness, combine to produce a mountainous impression. It requires an effort of reason to correct the illusion of being surrounded by mountains of three thousand metres rather than by hills of three hundred feet.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. Frederic Harrison has been appointed Rede Lecturer for the present academical year.

The Chancellor has given official interpretations of certain statutes, respecting which doubts had been raised by the Council of the Senate. It appears that a Deputy Professor is declared competent and bound to perform all the functions of the Professor, and that it is not possible for the latter to reserve or to resume any of his duties during the term for which the Deputy is appointed. It also appears that the statutes give the University no power to forbid Readers or Professors from taking private pupils.

The grace for limiting the scope of Part I. of the Mathematical Tripos was rejected by 151 votes to 130; and that for abolishing the order of merit, and with it the Senior Wranglership, was rejected by 161 votes to 129. A considerable number of non-resident members of the Senate attended to register their votes. The other readjustments proposed by the Mathematical Board, chiefly affecting Part II. of the Tripos, were carried without a division.

WE learn from *Science* that the Regents of the University of California have adopted the policy of giving the professors of the University one year's leave of absence in seven. The Sabbatical year is widely recognised by American universities, and the opportunity it affords the professors of visiting distant countries and fellow-workers is invaluable. The custom could be introduced with advantage in our own universities and colleges.

THE London *Technical Education Gazette* announces that botanical gardens have been laid out in Battersea, Ravenscourt and Victoria parks. Good collections of plants, representing various natural orders, have been obtained, and the more important trees and shrubs in the parks have been labelled. These gardens have been specially provided for the use of teachers and students of botany. Teachers who desire to obtain tickets should apply to the secretary of the Board, 116, St. Martin's-lane, W.C., giving their names in full and the name of the school where they are teaching.

AT the distribution of the prizes and certificates gained by the students in connection with the City and Guilds of London Institute, on Thursday last, Sir Douglas Fox, addressing the students, said that to specialise in study too early was a great mistake. The great point was to lay the foundation as wide and as broad as possible. That done, the next thing was to properly apply what had been learned. Mr. Watney afterwards made a statement as to the results obtained during the past year, and mentioned that in one way or another the Clothworkers' Company had subscribed 85,000*l.* towards the maintenance of the institute. At the invitation of the Royal Commissioners appointed by Parliament to reorganise the University of London, the executive committee have recently accepted the position of a "school of the University" for its Central Technical College.

THE results of an inquiry into the development of technical education in connection with English Secondary Schools during the past decade, made by the National Association for the Promotion of Technical and Secondary Education, are given in the current number of the *Record*. It appears from the report that in England alone, since 1889, 81 new public secondary schools have been established, while 215 existing schools have been extended mainly for the purposes of science teaching. As regards the schools in the latter category, the extensions to 195 of them have resulted in the addition of 251 physical and chemical laboratories, 77 workshops for manual training, 76 lecture-rooms, and 50 class-rooms. The total sum of money involved by these developments is 764,449*l.* Of this sum, local authorities have voted an amount of 147,496*l.*, the rating and borrowing powers of the Technical Instruction Acts being utilised to raise 20,707*l.* and the Residue Grant supplying the remainder. Taking *technical* and *secondary* schools together, as many as 664 schools have been affected by the efforts of County and County Borough Councils and other municipal authorities and of responsible public committees. Of this number of *technical* and *secondary* schools, 385 have been or are being established, while there are 279 existing schools which have been or are being extended or adapted. The capital expenditure incurred for these purposes *now* reaches in the aggregate 3,302,221*l.*, of which a sum of 1,896,110*l.*, or 57½ per cent., has been or is being supplied by local authorities from Imperial Funds or from local rates.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society (December 1, 1899–January 2, 1900).—(1) The proceedings of the October meeting in New York City are summarised, and abstracts of some of the twelve papers read are given by Prof. F. N. Cole.—Note on the simply transitive primitive groups, by Dr. G. A. Miller, contains some theorems and corollaries which are closely connected with a paper by the author in the *Proceedings* of the London Mathematical Society (vol. xxviii. pp. 533–544). The same writer contributes a short note on the commutators of a given group. Two theorems given are, every substitution of the alternating group of degree n ($n > 4$) is a commutator of two substitutions of the same group. "If the order of a cyclical group is odd, it is the commutator sub-group of its holomorph, and all its operators are commutators of this holomorph. When this order is even, the commutator sub-group of the holomorph includes half of the operators of this cyclical group, and all these operators are commutators of this holomorph." These results are partly supplementary to those contained in Dr. Miller's paper on the commutator groups (*Bulletin*, vol. iv.).—Dr. Lovett gives an account of Oltramare's Calcul de généralisation. From it we learn that this is the magnum opus of the writer, who is probably

the oldest living pupil of Cauchy. It sums up the work done by the Professor during the last twenty years. Several short notices, notes and new publications complete the number.

(2) The number opens with the President's (Prof. R. S. Woodward) address, delivered before the Society at its sixth annual meeting, December 28, 1899. It is entitled "The Century's Progress in Applied Mathematics." We learn from the "Notes" that the address has been printed in a separate pamphlet (25 cents each).—The status of imaginaries in pure geometry, by Prof. Charlotte Scott, is a paper which was communicated at the October meeting. Her text is the works of Von Staudt and Reye. She remarks that "it is one of the axioms of modern mathematics that Von Staudt placed the doctrine of imaginaries on a firm geometrical basis; but logical and convincing as his treatment is, when patiently studied in all its detail, it yet seems to me hardly practicable as a class-room method"; and then she proceeds concisely to examine the writings of the two above-named mathematicians, so far as they treat of imaginaries in pure geometry. The usual matter follows.

Bollettino della Società Sismologica Italiana, vol. v. 1899-1900, Nos. 4, 5.—On the present state of Vesuvius (July 3, 1899) and on the endogenous rising of the new lavic cupola during the months of February and March, 1898, by R. V. Matteucci.—The central explosion of Etna on July 19, 1899, by S. Arcidiacono.—On the activity of the volcanoes Vesuvius, Etna, Vulcano, Stromboli and Santorin in the autumn of 1898, by R. V. Matteucci.—The crater of Etna after the explosions of July 19 and 25, 1899, by A. Mascari. The effects of the explosions on the terminal cone and the internal condition of the crater are described.—New type of seismoscopic clock, by G. Agamennone.—Summary of the seismography of the earthquake of November 16, 1894, in Calabria and Sicily, by A. Riccò. A reprint of a memoir already noticed in NATURE.—Notices of earthquakes recorded in Italy (April 23-July 21, 1898), by G. Agamennone and A. Cancani, the most important being the earthquakes of Tripolitza (Greece) on June 2-3, Rieti on June 28, and Dalmatia on July 2, and earthquakes of distant origin on April 29, May 8 and June 22 and 29.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 18.—"Further Observations on 'Nitragin' and on the Nature and Functions of the Nodules of Leguminous Plants." By Maria Dawson, B.Sc. (Lond. and Wales), 1851 Exhibition Science Research Scholar. Communicated by Prof. H. Marshall Ward, F.R.S.

In the continuation of the author's work (see *Phil. Trans.* vol. 192, p. 1, 1899) in the Cambridge Botanical Laboratory, cases have been observed—*e.g. Phaseolus, Desmodium, Acacia*—in which the filaments containing the organism disappear from the nodules at a very early age: no sharp distinction can be drawn between these and the nodules of *Pisum, Lupinus*, &c., where the filaments abound in much older nodules, but the suggestion arises that the mode of growth depends on special adaptations of the organism to the conditions in the cells of the nodules in each host. A marked crystal-layer occurs in the nodules of some genera; in others—*e.g. Desmodium, Robinia*—peculiar apple-green, nucleus-like cell contents are found. The organisms are unusually large in *Desmodium, Coronilla, Psoralea*, and some others; and single rods, isolated from pure cultures, of those from *Desmodium* were observed continuously under high powers in hanging drops, and their growth traced. *The X and Y-shaped bacteroids arise by distinctly lateral branching of the straight rods.* After twelve to fourteen days these break up into shorter rodlets. Pure cultures were made on various media, and the organism was successfully grown on silica jelly with nutrient salts. In seven days, at 17° C., colonies of the *Desmodium* organism were as much as 30 μ in diameter. The author is employing this method for testing the power of the organism to fix nitrogen.

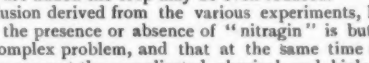
Comparisons of "nitragin" with pure cultures from *Pisum* and *Desmodium* show that all grow readily on gelatine or agar with additions of extract of pea-stems, asparagin and sugar; less readily on potato. Milk is not peptonised. A thick zoogloea forms on a decoction of peas. The organism is aërobic, does not ferment sugars, and may pass through a short motile stage. Other bacteriological characters are also examined, including the influence of temperature on infection of the root-hairs of the pea.

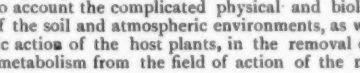
The author's experiments with reciprocal infections of organisms from one genus of Leguminosæ to another, point to there being but one species concerned, but this is probably split up into several culture-races, specialised to the various agricultural and other plants concerned, as in the case of the rust-fungi, yeasts, &c.

Crop-cultures of peas infected with the organism, in sterilised soil, ordinary soil, sand, sub-soils, &c., gave contradictory results. In a few cases a small increase was got by the use of the organism alone; but in other cases where nitrates were used instead the crop was larger. When nitrates as well as "nitragin" are added the crop may be even reduced.

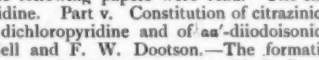
The conclusion derived from the various experiments, however, is that the presence or absence of "nitragin" is but one factor in a complex problem, and that at the same time must be taken into account the complicated physical and biological conditions of the soil and atmospheric environments, as well as the symbiotic action of the host plants, in the removal of the products of metabolism from the field of action of the nodule organisms.

Chemical Society, February 1.—Prof. Thorpe, President, in the chair.—The following papers were read.—The chlorine derivatives of pyridine. Part v. Constitution of citrazinic acid. Formation of $\alpha\alpha'$-dichloropyridine and of $\alpha\alpha'$-diiodoisonicotinic acid, by W. J. Sell and F. W. Dootson.—The formation of heterocyclic compounds, by S. Ruhemann and H. E. Stapleton. Benzamidine and ethyl phenylpropiolate react with formation of an intermediate product, $NH\langle^{CO.C:CPh}_{CPh:NH}$, which then condenses, yielding

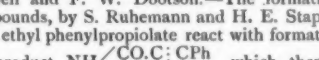
benzalphenylglyoxalidone, 

and diphenylpyrimidone, 

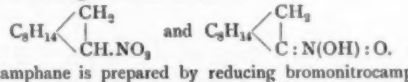
Urea, thiourea and guanidine condense with ethyl phenylpropiolate yielding substituted hydantoins.—The space configuration of quadrivalent sulphur derivatives. Methylethylthetine dextrocamphorsulphonate and dextro-α-bromocamphorsulphonate, by W. J. Pope and S. J. Peachey. The authors have prepared thetine salts of the constitutions



and



containing optically active acid radicles, and show that the basic thetine radicle is not optically active. They conclude that in a thetine the sulphur atom and the four atoms directly attached to it lie in one plane.—Nitrocamphane, by M. O. Forster. The author has prepared nitrocamphane and pseudonitrocamphane, to which he assigns the constitutions



Nitrocamphane is prepared by reducing bromonitrocamphane, and yields pseudonitrocamphane when its potash solution is acidified.—The absorption spectra of ammonia, &c., by W. N. Hartley and J. J. Dobbie.—Isoamarine, by F. R. Japp and J. Moir. The isoamarine of Feist and Arnstein obtained by heating *s*-dibenzoyl-*r*-diphenylethylenediamine in hydrogen chloride gas is identical with Snape and Brooke's isoamarine.—On the condensation of formaldehyde with ethyl malonate and on the synthesis of pentamethylenetricarboxylic acid, by J. F. Bottomley and W. H. Perkin, junr. In addition to the substances previously described as resulting from the condensation of formaldehyde with ethyl malonate, it is shown that ethyl pentanehexacarboxylate,

$$(CO_2Et)_2CH.CH_2.C(CO_2Et)_2.CH_2.CH(CO_2Et)_2,$$

may also be formed. It is hydrolysed by baryta, yielding propanetetracarboxylic acid, $(CO_2H)_2CH.CH_2.CH(CO_2H)_2$, and by hydrochloric acid with formation of the corresponding acid, which on heating to 200° gives pentanetricarboxylic acid, $CO_2H.CH_2.CH_2.CH(CO_2H).CH_2.CH_2.CO_2H$. — The volumetric estimation of potassium, by R. H. Adie and T. B. Wood. The authors precipitate potassium as its cobaltinitrite,

$$K_6Co_2(NO_2)_{12},3H_2O,$$

and titrate the nitrite with permanganate in acid solution.—On the action of aluminium chloride on camphoric anhydride, iii., by F. H. Lees and W. H. Perkin, junr.

Linnean Society, February 1.—Dr. A. Günther, F.R.S., President, in the chair.—The President announced that on the occasion of the forthcoming International Exhibition in Paris, an International Congress of Botany will be held there from October 1–10, both dates inclusive.—Mr. George Massee exhibited lantern-slides in illustration of his paper on the origin of the Basidiomycetes, the substance of which had been communicated at the last meeting, and recapitulated the conclusions at which he had arrived.—Mr. Cecil R. P. Andrews exhibited two non-British grasses which he had found last year in the Channel Islands—*Phalaris minor*, Retz., from sandy shores and fields in Guernsey and Alderney, and *Milium scabrum*, Merl., from the cliffs of Guernsey.—Mr. J. E. Harting exhibited a specimen in the flesh of the Rufous Tinamu (*Rhynchotus rufescens*) which had been shot near Petersfield, Hants, on January 29, and gave some account of the experiments which had been made to acclimatise this South American gamebird since its first introduction by Mr. John Bateman at Brightlingsea, Essex. No difficulty had been experienced in regard to climate or food, but inasmuch as these birds do not perch in trees like pheasants, but roost on the ground, they are more liable to destruction by foxes, a circumstance which has materially affected their increase.—A report was read on the zoological results of an expedition to Mt. Roraima in British Guiana, undertaken by Messrs. F. V. McConnell and J. J. Quelch in 1898; communicated to the Society by Prof. Lankester, F.R.S., on behalf of the members of the British Museum staff who had prepared it. A previous journey, occupying sixty days, had been made by the same travellers in 1894, their route then being by the rivers Essequibo and Rupanuni. The route selected in 1898, by the Mazaruni river, to the Falls of Macrobah, occupied forty days only, twenty of which were spent in boats. With the exception of the last twenty miles, the entire journey lay through thick forest. Mt. Roraima (8700 feet) was found to have a sloping base clothed with dense vegetation, surmounted by a rectangular mass fifty-four square miles in area with perpendicular walls 2000 feet in height. On the south-west, part of the wall has slipped, and lies diagonally across the face of the upper portion of the mountain. By following the ledge so formed, the summit can be reached without serious difficulty. Amongst the Mammalia collected, a new mouse, described by Mr. De Winton as *Rhipidomys Macconnelli* (resembling *R. microtis* from Columbia, but darker in colour and with larger ears) was found near the summit. Amongst birds a new *Zonotrichia*, allied to *Z. pileata*, which is found throughout the greater part of Central and South America, is described by Dr. Bowdler Sharpe. Mr. G. A. Boulenger furnishes descriptions of some new reptiles (*Neusticurus rudis* and *Prionodactylus leucostictus*) and Batrachians (*Oreophrynella Macconnelli*, *Hylodes marmorata*, and *Otophryne robusta*), the last named being assigned to a new genus. Amongst Crustacea, of which a number were collected in the Upper Mazaruni river at an altitude of 2500 feet, Dr. De Man detected a new species of *Palaemon*, which he has named after Mr. Quelch. The collection of Myriopoda was found to contain new species of *Odontopellis* and *Enyurus*, of which descriptions are given by Mr. Pocock, who had already described two new spiders (*Ann. M. N. H.* ser. 6, xvi. p. 140) collected on this expedition. Two scorpions (*Broteochactus granosus* and *B. porosus*) are likewise characterised as new. A new Hemipteron (*Acrocoris perarmata*) and a new beetle (*Exagontus denticollis*) are described respectively by Mr. Kirby and Mr. C. O. Waterhouse, the latter insect being referred to a new genus.

Zoological Society, February 6.—Mr. Howard Saunders, Vice-President, in the chair.—The Secretary called attention to the breeding of a pair of black-headed buntings (*Emberiza melanocephala*) in the western aviary, about the middle of the month.—Mr. Oldfield Thomas exhibited and made remarks on some mounted heads of antelopes obtained on the Upper Nile by Captain H. G. Majendie. Amongst these were specimens of *Cobus maria*, *C. leucotis*, *Damaliscus tiang*, and *Gazella rufifrons*.—Mr. G. E. H. Barrett-Hamilton exhibited skins of the continental and British dormice, which he characterised as distinct, and proposed the subspecific name of *anglica* for the British form.—Mr. Barrett-Hamilton also exhibited skins of the variable hare (*Lepus timidus*, Linn.) from Scotland and Ireland, to show their subspecific characters; and gave a short synopsis of palæarctic variable hares, describing as subspecifically new, under the name of *Lepus timidus ainu*, the representative form of the island of Yezo.—Mr. R. Trimen, F.R.S., communicated a paper by Lieut.-Colonel J. Malcolm Fawcett, entitled "Notes on the Transformations of some South-African Lepidoptera." This memoir was accompanied by a series of careful and characteristic coloured drawings from life of larvæ and pupæ collected by the author during a residence in Natal, chiefly at Ladysmith and Maritzburg. The early stages of seventeen Rhopalocera and thirty-one Heterocera were described and figured. Nearly all of these appeared to have been previously unpublished, and in the few instances where previous publication had occurred, the illustrations had been inexact or insufficient. In several species, not only the variations of the full-grown larvæ, but the changes exhibited at successive moults were well shown, especially in the Natalian species of *Papilio*. Among the Heterocera was specially noticeable the striking series of Saturniid larvæ, and still more the huge and extraordinary caterpillar of *Lophostethus dumolinii*, one of the largest of the Smerinthine hawk-moths, which, in addition to the usual caudal horn, bears many strong branched spines distributed over nearly the whole of the body. Colonel Fawcett's descriptions and drawings were accompanied by notes of value on the distribution, food plants, &c., of the species concerned. Mr. Trimen expressed his deep regret (which he felt the Fellows of the Society would share) that the talented writer of this memoir, who had rejoined his regiment in Natal, was among those officers who were known to have been severely wounded during the siege of Ladysmith.—Mr. L. A. Borradaile read a paper on a small collection of decapod crustaceans from freshwaters in North Borneo. The specimens were referred to four species, of which one was a prawn and three were crabs. Of the latter one was considered to be new, and was described under the name of *Potamon kadamaianum*.—Mr. Oldfield Thomas read a paper on the mammals obtained in South-western Arabia by Messrs. Percival and Dodson during the autumn of last year. Twenty-eight species were enumerated, and the collectors' field-notes upon them were given.—A communication was read from Dr. R. W. Shufeldt on the feigning of death in fishes, based principally on observations made on specimens of *Pseudopriacanthus altus* and *Epinephelus niveatus* in the Aquarium of the United States Fish Commission at Washington.—A communication was read from Dr. A. G. Butler containing a revision of the butterflies of the genus *Zizera* (Fam. *Lycaenidae*) in the collection of the British Museum. According to the author's views the genus *Zizera*, so far as was at present known, comprised sixteen species. These were enumerated and their specific differences were pointed out.

Entomological Society, February 7.—Mr. G. H. Verrall, President, in the chair.—The President announced that he had appointed Dr. T. A. Chapman, Mr. W. L. Distant, and Mr. C. O. Waterhouse as Vice-Presidents.—Mr. O. E. Janson exhibited examples of *Achias longividens*, Walk., a remarkable fly from New Guinea, in which the eyes are set at the end of very long stalk-like processes. The specimens showed great variation in the length of the eye-stalks, which in the most fully developed males considerably exceeded the length of the wings.—Mr. J. W. Tutt exhibited a series of specimens of *Epunda lutulenta*, including several remarkable variations.—Mr. Champion exhibited a large number of Coleoptera collected in Switzerland. He called attention to the great variation in colour of one or two common species of the Chrysomelid genus *Orina*, and said he believed that the forms known as *O. cacaliae*, Schrank, *O. speciosissima*, Scop., and under other names, all belonged to one extremely variable species.—Prof. T. Hudson Beare showed specimens of *Dinoderus minutus*, Fab., obtained from a bamboo-basket in his house at Richmond.—Mr. H. Donisthorpe exhibited a larva-case of *Clythra quadripunctata* taken from a nest of the red-wood ant—*Formica rufa*. He commented upon the unsatisfactory state of our knowledge as to the food-habits of the larvæ of *Clythra*, and said he believed the larvæ fed upon the eggs of the ant.—Mr. Gahan mentioned, in connection with the genus *Clythra*, that these beetles possess a stridulating organ on the meso-notom, not along the middle as in Longicorns and Megalopidæ, but towards the lateral edges, and consisting of two widely separated striated areas over which the edge of the pronotum moves. The stridulating areas were present, he said, in nearly all the genera of Clythridæ, and might almost be regarded as a characteristic of the family. The fact that these

beetles stridulate was apparently known to Darwin, who, in the "Descent of Man," erroneously stated that the stridulating area was situated on the pygidium.

DUBLIN.

Royal Irish Academy, February 12.—Dr. Benjamin Williamson, F.R.S., Vice-President, in the chair.—Prof. Charles J. Joly read a paper on the place of the *Ausdehnungslehre* in the general associative algebra of the Quaternion type. He pointed out that the cardinal distinction between quaternions and other systems of space analysis lies in the thoroughly associative and distributive character of the former. He showed that a Grassmann system applicable to a space of n dimensions is equivalent to a very restricted use of the associative algebra of $n+1$ units obeying the laws $i_0^2 = -1$, and $i_0 i_r + i_r i_s = 0$. In fact, a progressive product is simply the part of highest order in the units in a complete product in the associative algebra. Regressive products are formed by the simple artifice of dividing "products" of order $n+1$ by the product of all the units, and then starting afresh. The point symbol may be considered to be introduced by the artifice of leaving the origin arbitrary exactly as Hamilton has done, but somewhere in the fourth dimension when dealing with Euclidian space.—Prof. Grenville A. J. Cole read a paper on metamorphic rocks in eastern Tyrone and southern Donegal. The gneissic axis north of Pomeroy is shown in this paper to be invaded by granite of the Slieve Gallion type, and the metamorphism of the central region thus occurred, in all probability, prior to the "Caledonian" earth-movements. The gneiss itself, however, rarely shows the effects of pressure, and its structures seem due to the invasion of basic schists by an aplitic granite at some early period. Direct comparison is made between its structures and those that are clearly due to the invasion of the Slieve Gallion granite into schists at Fir Mountain. The large area west of Pettigo in South Donegal similarly shows a foliated granite (the archæan gneiss), which owes most of its foliation to the inclusion and streaking out of masses of pre-existing amphibolite. Bands of micaceous rock are formed from the partial absorption and metamorphism of garnet-pyroxenites and garnet-amphibolites. The latter rocks may have been sedimentary, and are now found as great "eyes" and lenticles, round which the pure white gneiss flows, and into which it sends off veins. The boundary between the Dalradian schists and the gneiss is sufficiently obscure in this area for it to be possible that the amphibolites were originally the lower members of the Dalradian series. At any rate, they represent a floor on which the Dalradians were laid down. The gneiss is in no sense the fundamental rock; it is, however, traversed by later granite veins, which belong probably to the Caledonian intrusions. As in some French districts, the metamorphic area of South Donegal shows the effects of igneous intrusion and contact-metamorphism on a regional scale, and dynamic metamorphism has played but a minor part in determining its structures.

PARIS.

Academy of Sciences, February 12.—M. Maurice Lévy in the chair.—The President announced to the Academy the loss it had sustained by the death of M. Emile Blanchard, member of the Section of Anatomy and Zoology.—Researches in the uric acid series, by M. Berthelot. Determination of the heats of combustion and formation of methyl purine, hypoxanthine, 8-oxypurin, and 7-methylhypoxanthine.—On the dispersion of the radium rays in a magnetic field, by M. Henri Becquerel. A continuation of work previously published upon the same subject. The experiments were carried out in a uniform magnetic field, of intensity H, and the radius of curvature, ρ, of the path of the ray measured, $H\rho$ being constant. The lower limit of $H\rho$ was measured when screens of various substances (paper, aluminium, mica, glass, platinum, &c.) were interposed. Some of the phenomena observed are not capable of explanation by any simple hypothesis.—The synthesis of campholic acid by means of camphoric acid, by MM. A. Haller and G. Blanc. The steps of the synthesis are as follows: camphor is oxidised to camphoric acid, and this reduced with sodium amalgam to campholide. This, by treatment with hydrobromic acid and subsequent reduction, yields campholic acid.—M. Schwendener was elected a correspondant for the Section of Botany, in the place of the late Baron de Müller.—Rapid variations of radial velocity of the star δ-Orion, by M. H. Deslandres. Eleven photographs of the spectrum of δ-Orion is taken between December 8, 1899, and January 25, 1900, showed that this star possesses periodic variations in its radial velocity, the period being about 1·92 days.—The dynamical laws of cyclones, by M. Admiral Fournier. The author deduces an expression correlating the barometric pressures at two points, and the corresponding distances from the centre of the cyclone, which will be of practical service in navigation.—On the tangeut circles to four isotropic planes; and on surfaces of double circular generation, by M. Eugéne Casserat.—On harmonic equations and isothermal surfaces, by M. A. Thybaut.—On anharmonic algebraic equations, by M. Autonne.—Plausible value of a variable magnitude, by M. Estienne.—On two problems in probability, by M. Andrade. A rectification of a note previously published.—On the method of Neumann and Dirichlet's problem, by M. W. Stekloff.—On the zeros of real integrals of linear equations of the third order, by M. Davidoglou.—On the constitution of white light, by M. E. Carvallo. A reply to the criticism of M. Gouy.—On some consequences of the prism formulæ, by M. A. de Gramont.—A new source of light for spectrometry of precision, by MM. Ch. Fabry and A. Perot. An arc is formed between two metallic poles, one of which is kept in rapid oscillation, the whole apparatus being *in vacuo*. The troubles incident to the production of a continuous arc in a vacuum are overcome by the device of keeping one pole in oscillation.—A comparison of various patterns of the Wehnelt contact-breaker, by M. Alfred Turpain. From the point of view of duration and economy, the form with holes suggested by Caldwell is preferable to the form with platinum wire. For usefulness and rapidity either pattern of Wehnelt interrupter is better than the Foucault contact-breaker.—On thermomagnetic currents, by M. G. Moreau. The author regards his experiments as proving that the Hall phenomenon is due to a deformation of the plate under the influence of the magnetic field.—Complete synthesis of the phorone of camphoric acid, by M. L. Bouveault. From adipic acid α-methylcyclopentanone is prepared, and this, condensed with acetone, gives the phorone of camphoric acid.—On the composition of essence of sandal wood from the East Indies, by M. M. Guerbet. Two isomeric hydrocarbons were isolated, each of the composition $C_{15}H_{24}$, and distinguished as α- and β-santalene. A mixture of alcohols $C_{15}H_{24}O$, an aldehyde, santalal, and two acids were also obtained, further investigations on which will be proceeded with.—Transformation of nitrobenzene into aniline by an organic reducing ferment, by MM. E. Abelous and E. Gérard. The ferment present in the kidney of the horse, which in previous papers has been shown to be capable of reducing nitrates to nitrites, is now found to reduce nitrobenzene to aniline.—Researches on the digestion of the reserves in seeds in the course of germination, and their assimilation by the young plant, by M. Mazé. Seeds containing oil are capable of transforming the group CH_2 into an alcoholic group CH(OH) by taking up oxygen from the air.—New researches on the evolution of the monstrillids, by M. A. Malaquin.—On a form of optically negative anhydrous silica, by M. A. Lacroix. The mineral described consists of anhydrous silica containing a little opal, and is found in widely differing strata. Its density is about 2·5; it is biaxial and optically negative. It is clearly differentiated from quartzine, lutecite and chalcedony, and it is proposed to name it pseudo-chalcedonite.—On some granitic rocks of Cape Marsa, by MM. L. Duparc and F. Pearce.—Examination of a meteorite which fell at Bierbélé, near Borgo, in Finland, on March 12, 1899, by M. Stanislas Meunier.—Specific heats of some organic substances, by M. G. Fleury. The specific heats of cellulose, wool and leather are given.

AMSTERDAM.

Royal Academy of Sciences, December 30, 1899.—Prof. Stokvis in the chair.—Report by Prof. Martin and Prof. Behrens on the paper, presented by Dr. H. van Cappelle, entitled "New observations on the Dutch dilivium, especially with a view to mapping out this formation (II.)." The conclusion arrived at, viz. to insert this paper in the *Transactions* of the Academy, was approved of.—Prof. Kluyver made a communication, entitled "Borel's summation-formulæ for divergent series." In this paper the author discusses a slight modification of these formulæ, which were suggested by Mr. Borel in his "Mémoire sur les séries divergentes," (*Ann. de l'École norm.*, t. 16, p. 77, footnote).—Prof. Van der Waals presented a communication, by Mr. J. D. Van der Waals, jun., entitled "The entropy of radiation." The principle of entropy has had to be constantly extended. Originally, entropy was attributed to conditions of equilibrium only. In accordance with the

theorem that a system, which approaches a new condition of equilibrium by a non-convertible process and might do so in various ways, compatible with the given combinations, changes its conditions in such a way that the entropy constantly increases, it has become necessary to attribute entropy to conditions of non-equilibrium as well. If this theorem is to hold good generally, entropy has also to be attributed to radiation. In his H theorem Boltzmann has given a formula for the entropy in the case of material molecules that are not in a condition of maximum entropy and consequently not in equilibrium. The author is endeavouring to find a similar formula for radiation. He considers the action of an electrical force upon electrical vibrators as an analogue of the collisions of material molecules.—Prof. W. Kapteyn presented a supplement to the communication made at the meeting of November 25, 1899, entitled "On certain special cases of Monge's differential equation."—Prof. Winkler presented a paper, by Mr. P. H. Eykman, entitled "A new graphical system of craniology." Instead of the absolute measurements of the skull, Schmidt employs the relative ones, which he obtains by multiplying the absolute ones by $\frac{300}{L+B+H}$, by which their sum becomes constant = 300. Geometrically, the triple system of ordinates is thereby changed into a double one, in the shape of an equilateral triangle. All three measures are equal in it, and this method is adapted for a rough survey of a large group of skulls. Alsatian skulls, published by Dr. Blind (537 in number), drawn in the system, serves as an example.—Prof. Bakhuis Roozeboom presented a paper, by Dr. Ernst Cohen, entitled "On the theory of the transition elements of the third kind (I.)."—Prof. Moll presented a paper, by Miss Tine Tammes, entitled "Pomum in pomo." Within a large apple, presented by Prof. C. A. J. A. Oudemans, there is another smaller apple, which is entirely disconnected from the surrounding one. The entire texture of the inner apple is filled up with a mycelium, while the fungus in the outer one is altogether lacking. The presence of the fungus in the interior of the original, normal apple is the cause of the monstrosity.—Prof. Franchimont presented two papers, by Dr. P. van Romburgh, of Buitenzorg, entitled (*a*) "On the nitration of dimethyl aniline in a solution of strong sulphuric acid"; (*b*) "On the formation of indigo from Indigoferas and from Marsdenia tinctoria."—Prof. Kamerlingh Onnes presented a paper, by Mr. E. van Everdingen, jun., on Hall's effect and the increase of magnetical resistance in bismuth at very low temperatures (I.) (continuation).—Prof. Van der Waals presented a paper, by Dr. P. Zeeman, entitled "Observations concerning an asymmetrical change in the spectral lines of iron radiating in a magnetic field." The observations were made at the request of Prof. Voigt, of Göttingen, who deduced from theory that in weak magnetic fields a triplet tends to become asymmetrical, having the more intense component on the less refrangible side, the component on the violet side being at the same time at a greater distance from the original line than the second outer component. Measurements made on negatives proved the existence of asymmetrics, which in many cases were in accordance with theory. A few exceptions to theory were, however, noticed. All the above papers will be inserted in the Academy's *Proceedings*.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 22.

ROYAL SOCIETY, at 4.30.—Total Eclipse of the Sun, January 22, 1898. Observations at Viziadrug: Sir N. Lockyer, K.C.B., F.R.S., Captain Chisholm-Batten, R.N., and Prof. Pedler, F.R.S.—Preliminary Note on the Spectrum of the Corona, Part II.: Sir N. Lockyer, K.C.B., F.R.S.—On the Structure of Coccospheres and the Origin of Coccoliths: Dr. H. H. Dixon.—The Ionisation of Dilute Solutions at the Freezing Point: W. C. D. Whetham.

ROYAL INSTITUTION, at 3.—Modern Astronomy: Prof. H. H. Turner, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Standardisation of Electrical Engineering Plant: R. Percy Sellon. (Adjourned Discussion.)

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Improvements in the Longworth Power-Hammer: Ernest Samuelson.—Portable Pneumatic Tools: Ewart C. Amos.

FRIDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 9.—Recent Studies in Gravitation: Prof. J. H. Poynting, F.R.S.

PHYSICAL SOCIETY, at 5.—Prof. R. W. Wood will exhibit and describe his Photographs of Sound Waves and the Kinematographical Demonstration of the Evolutions of Reflected Wave-fronts: a New Seudoscope: Diffraction Colour-Photographs; Artificial Parhelia.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Bearing Springs: B. Humphrey and H. E. O'Brien.

MONDAY, FEBRUARY 26.

INSTITUTE OF ACTUARIES, at 5.30.—Surrender Values and the Principles which underlie their Calculation: F. W. Fulford.

SOCIETY FOR THE PROTECTION OF BIRDS (Westminster Palace Hotel), at 3.—Annual Meeting.

TUESDAY, FEBRUARY 27.

ROYAL INSTITUTION, at 3.—Structure and Classification of Fishes: Prof. E. Ray Lankester, F.R.S.

SOCIETY OF ARTS (Foreign and Colonial Section), at 4.30.—Agricultural Education in Greater Britain: R. H. Wallace.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Corrosion of Marine Boilers: John Dewrance.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Electricity in connection with Photographic Action: W. Friese-Greene.

WEDNESDAY, FEBRUARY 28.

SOCIETY OF ARTS, at 8.—Pneumatic Dispatch: Prof. Charles A. Carus-Wilson.

THURSDAY, MARCH 1.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: An Experimental Inquiry into Scurvy: F. G. Jackson and Prof. Vaughan Harley.—The Velocity of the Ions produced in Gases by Röntgen Rays: Prof. J. Zeleny.—Mathematical Contributions to the Theory of Evolution. VIII. On the Correlation of Characters not Quantitatively Measurable: Prof. K. Pearson, F.R.S.

LINNEAN SOCIETY, at 8.—On Botanic Nomenclature: C. B. Clarke, F.R.S.—On some Foraminifera of Tithonian Age from the Limestone of Nesseldorf: F. Chapman.

CHEMICAL SOCIETY, at 8.—Pilocarpine and the Alkaloids of Jaborandi Leaves: Dr. H. A. D. Jowett.—Isomeric Partially Racemic Salts containing Pentavalent Nitrogen, Parts I.–VII.: Prof. F. S. Kipping, F.R.S.—New Synthesis of Indene: Prof. F. S. Kipping, F.R.S., and Harold Hall.—(1) Potassium Nitrito-hydroximidosulphates and the Non-existence of Dihydroxylamine Derivatives: (2) Identification and Constitution of Fremy's "Sulphazotised Salts of Potassium": Dr. E. Divers, F.R.S., and Dr. T. Haga.—Some Acids obtained from α-Dibromocamphor: A. Lapworth and E. M. Chapman.

FRIDAY, MARCH 2.

ROYAL INSTITUTION, at 9.—Malaria and Mosquitoes: Major Ronald Ross.

PHYSICAL SOCIETY (University College), at 4.30.—The Relative Rates of Effusion of Argon, Helium, and some other Gases: Dr. F. G. Donnan.—On the Distillation of Liquid Air and the Composition of the Gaseous and Liquid Phases: E. C. C. Baly.—The Reversibility of Galvanic Cells: T. S. Moore.—On the Damping of Galvanometer Needles: M. Solomon.

SATURDAY, MARCH 3.

ROYAL INSTITUTION, at 3.—Polarised Light: Lord Rayleigh.

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